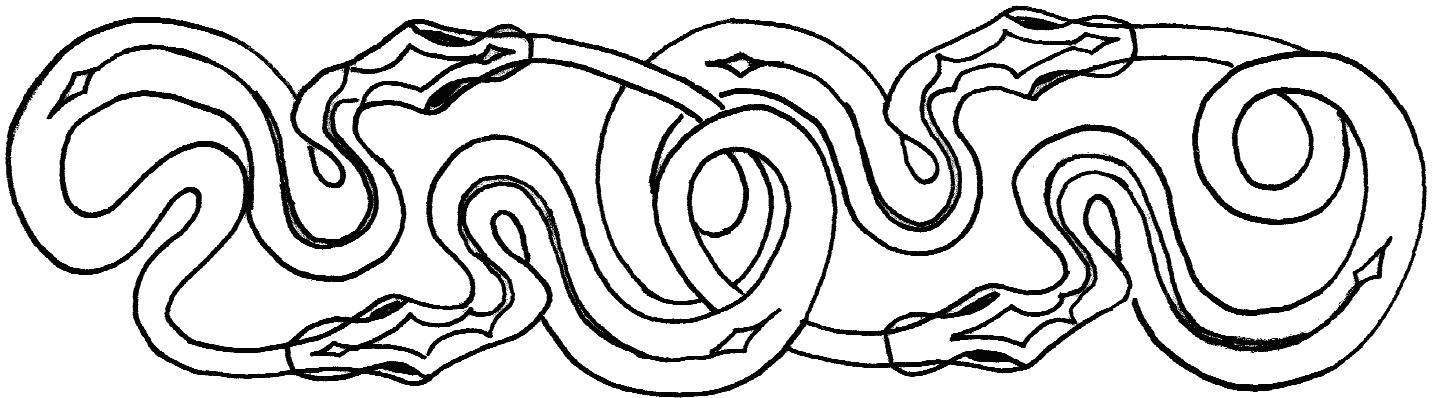


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FIRM STRATEGIES IN THE COMPETITION FOR DOMINANCE OF NETWORKED BUSINESS SYSTEMS

Antti Sillanpää



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Antti Sillanpää

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Helsinki University of Technology
Department of Industrial Engineering and Management
Institute of Strategy and International Business
P.O. Box 5500
FIN-02015 TKK, Finland
Tel. + 358-9-451 2846
Fax. + 358-9-451 3095
E-mail: antti.sillanpaa@tkk.fi
Internet <http://www.tuta.hut.fi/isib>

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ABSTRACT

The dissertation aims to contribute to the body of research on firm strategies in the context of network externalities, in order to better understand firm level competitive behaviour. The dissertation specifically focuses on the interaction of different types of firms when the focal firms are competing for dominance in an evolving networked business system. The research question is: What are the drivers affecting competitive behaviour in a network externality context, and what are the firm and aggregate level consequences of the competitive actions?

The study uses bibliometric methods to map the scientific discourse about the phenomenon. The mapping highlights the relevant theoretical approaches investigating the phenomenon, including the evolutionary perspective on economics and population ecology. Researchers of these approaches have identified positive and negative feedback mechanisms leading to different competitive outcomes. Positive feedback is associated with divergence and diversification, while negative feedback is associated with congruence, imitation, and competitive effects. The dissertation investigates the positive and negative mechanisms in an empirical setting.

The investigation focuses on one business environment at the time of the commercial introduction of a new technology. The investigated period was the launch of digital television in the United Kingdom between 1998-2002, the era between the commercial launch and an industry shakeout. The study builds on data from interviews, press releases, trade journals, internet discussion fora and stock market information. With the case approach, the dissertation aims at offering a rich view of the field while subjecting it to methodological and data triangulation. The analysis proceeds from the case narrative to social network analysis, content analysis, and qualitative comparative analysis.

The case evidence describes how firms engaged in intense, resource-draining competition, with an outcome of increased aggregate adoption rates. In contrast to earlier work on network externalities, the dissertation emphasises that firms imitate at an early stage of market creation. The study shows that all firms - including the industry leader - are inclined to follow competitors' behaviour at a time of intense rivalry. Building on previous research and the case examination, a new competitive metaphor and an integrated model of network market competition are developed. The dissertation contributes to the understanding of firm strategies in the presence of significant network externalities and proposes implications for managers and policy makers.

TIIVISTELMÄ

Tutkimus tarkastelee yritysstrategioita ympäristössä, jossa verkoston ulkoisvaikutukset ovat merkittäviä. Tavoitteena on paremmin ymmärtää yritysten kilpailukäyttäytymistä. Tarkastelussa huomio kohdistetaan yrityksiin, jotka pyrkivät johtoasemaan kehittyvässä ja verkottuneessa kilpailutilanteessa. Keskeiset tutkimuskysymykset ovat, mitkä tekijät vaikuttavat kilpailukäyttäytymiseen verkoston ulkoisvaikutusten muokkaamassa ympäristössä ja mitkä ovat kilpailullisten toimenpiteiden seuraukset yrityksen tasolla ja sitä laajemmin.

Bibliometrisen menetelmän avulla tutkimus kartoittaa ilmiöstä käytyä tieteellistä keskustelua. Bibliometrinen kartta osoittaa ilmiöön liittyvät teoreettiset lähestymistavat, joihin kuuluvat mm. evolutionaarinen taloustiede ja populaatioekologia. Lähestymistapojen tutkijat ovat tunnistaneet positiivisen ja negatiivisen vaikutusmekanismin, joiden kilpailulliset tulemat ovat erilaisia. Positiivinen dynamiikka liittyy kasvuun ja erilaistumiseen. Kilpailun yhdenmukaistavat vaikutukset ja matkiminen liittyvät negatiiviseen dynamiikkaan. Tutkimus selvittää empiirisesti positiivisia ja negatiivisia vaikutusmekanismeja.

Tutkimus tarkastelee liiketoimintaympäristöä tilanteessa, jossa uutta teknologiaa tuodaan markkinoille. Tutkimusajankohtana on digitaalisen television alkutaival Iso-Britanniassa vuosina 1998-2002. Ajanjakso alkaa digitaalisen television kaupallisen toiminnan käynnistymisestä ja päättyy alan murrosvaiheeseen. Tutkimus rakentuu tiedoille, jotka on kerätty haastatteluista, lehdistötiedotteista, alan lehdistä, internetin keskustelusivustoilta ja pörssi-informaatiosta. Tutkimus lähestyy aihetta tapaustutkimuksen keinoin pyrkien tarjoamaan vivahteikkaan kuvan kohteesta, mutta alistaen sen samalla menetelmien ja tietolähteiden ristituleen. Tapauskertomuksen jälkeen analyysi etenee sosiaalisten verkostojen analyysiin, sisällön analyysiin ja vertailevaan laadulliseen analyysiin.

Digitaalitelevisiomarkkinoiden kehitys kuvaa, kuinka yritykset osallistuivat intensiiviseen kilpailuun, joka kulutti niiden voimavaroja mutta samalla merkittävästi kiihdytti palvelun leviämistä. Poiketen vallitsevasta verkoston ulkoisvaikutusten tutkimuksesta tämä tutkimus näyttää kuinka yritykset imitoivat toisiaan markkinoiden rakentamisen alkuvaiheessa. Tutkimus osoittaa kuinka yrityksillä, mukaan lukien myös alan johtavalla yrityksellä, on taipumus ankarassa kilpailussa seurata toinen toisiaan. Työssä kehitetään verkostokilpailun malli, joka perustuu tämän tutkimuksen tarkastelukohteen analyysiin ja muuhun aikaisempaan tutkimukseen. Tutkimus auttaa parantamaan ymmärrystä yritysten strategioista ympäristössä, jossa verkoston ulkoisvaikutukset ovat merkittäviä. Tutkimus päättyy esittämään suosituksia yritysjohdolle ja muille päättäjille.

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1 INTRODUCTION

1.1 Background

A recent European Union study on the diffusion of digital television reported that the spontaneous firm strategies of independent firms may lead to market failures, "...these structural factors prevent the market players from acting in accordance with the general interest and even with their own long-term interest in some cases" (BIPE, 2002).

The observation above is one possible aggregate-level consequence of network externalities, or network effects. A service or product creates externalities when the benefit to the individual user increases with the total number of network participants (Rohlf's, 1974). Network externalities are typical in information technology (Shapiro & Varian, 1999b). Direct externality occurs when the number of users directly influences a product's utility as, for example, in telecommunication networks (Katz & Shapiro, 1985; Economides, 1996). Indirect network externality is present when the demand for a product is indirectly affected by the availability of complementary products (e.g. Katz & Shapiro, 1985; e.g. Economides, 1996; Gupta et al., 1999).

It has been shown that network evolution and adoption patterns are different when strong network externalities are involved, when compared to individual products or traditional markets (e.g. Oren & Smith, 1981; Katz & Shapiro, 1985; Katz & Shapiro, 1986b; Arthur, 1989; Church & Gandal, 1992; Suarez, 2004). Despite strong efforts, research on network evolution has not yet been able to bridge some important gaps. These gaps include the interactions of multiple, overlapping networks (Powell et al., 2005); relationships among different types of participants (Gupta et al., 1999; Venkataraman & Lee, 2004), and the nature of their performance (Majumdar & Venkataraman, 1998; Gallagher & Park, 2002). Empirical research linking firms' network attributes and their relationship to competitive actions is claimed to be practically non-existent (Katz & Shapiro, 1994; Liebowitz & Margolis, 1994; Wade, 1995; Brynjolfsson & Kemerer, 1996; Cottrell & Koput, 1998; Majumdar & Venkataraman, 1998; Kauffman et al., 2000; Gnyawali & Madhavan, 2001; Kauffman & Walden, 2001; Le Nagard-Assayag & Manceau, 2001; Schilling, 2002).

The dissertation belongs to the normative tradition of the firm strategic research stream. The evolutionary perspective has offered a significant contribution to strategy studies and has the potential to synthesise many different theoretical approaches in the field of strategy (Barnett & Burgelman, 1996; Nelson & Winter, 2002). The evolutionary approaches are at the centre of a major debate concerning the relative importance of selection versus adaptation in explaining organisational change and survival (Astley & Van de Ven, 1983; Hannan & Freeman, 1984; Burgelman, 1991). The evolutionary perspective on economics (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982) and population ecology (Hannan & Freeman, 1977, 1984) relate to network externalities, as they consider the dynamics in firm, industry and technological change and evaluate path-dependent mechanisms. The evolutionary perspective on economics has developed ideas about how some patterns of behaviour are further strengthened because of a positive feedback mechanism (Nelson & Winter, 1982), whilst population ecology has given an insight into the growth and survival of the firm population (Hannan & Freeman, 1977; Carroll, 1984; Hannan & Freeman, 1984).

The dissertation attempts to contribute to research on competitive behaviour in the network externality environment. The results support earlier findings that markets tend to act speculatively in a network externalities context (e.g. Besen & Farrell, 1994), but contrasts with the view of how the expected mechanisms actually work. The dissertation suggests that previous network externality modelling attempts have not fully captured how competitors' perceptions determine the 'rules of the game' (Porac et al., 1995). It has been suggested that network externalities lead to rapid market 'tipping' in which an early leader firm quickly gains an advantage, i.e. adoption rates increase significantly because potential adopters strongly favour a firm which is seemingly winning the competition (e.g. Besen & Farrell, 1994). In the dissertation I will establish how firms anticipate others' actions and change their own behaviour, with significant implications for the competitive outcomes. During competition, all competing firms try to manage the expectations of other network participants by giving an impression of their own viability. The case evidence describes how firms engage in intense, resource-draining competition, which results in increased aggregate adoption rates. Intensive competition amongst the major firms poses a dilemma for managers when they value (ex-ante) the negative aspects of

competitive pressures and the positive network effects of growth. Reasons for selecting (ex-post) inappropriate competitive strategies can be understood in terms of the cognitive perception of markets.

The dissertation illustrates that positive and negative feedback effects can have a mutually strengthening role. In the short term, the shared expectations of positive feedback intensify competition, causing strong negative feedback. Actions aimed at improving one's own position are systematically pre-empted. However, in the long term, as the weakest firms exit, the positive feedback effects are fully unleashed. The winning networks seem to enjoy the benefits predicted by network externality theorists, just later than expected. The losing networks have their losses magnified, because the stakes are higher and the game takes longer. By showing the dynamism and interplay of negative and positive feedback mechanisms in the evolution of an industry, the dissertation contributes to population ecology as well as to the evolutionary perspective on economics. As a theoretical advancement, a new industry level metaphor called the 'positive feedback spring' is suggested. The spring describes how negative feedback seemingly delays or eliminates the positive feedback effect. When the competitive period ends, positive feedback finally gains its full effect, like a spring relieved from the initial pressure. In competition, the positive feedback spring would appear to work to the advantage of the industry leader.

I examined one business environment at the time of the commercial introduction of a new technology. The empirical reference of this dissertation is the arrival of digital television. The dissertation also has descriptive value because the researched subject is still emerging and not yet well understood. The dissertation elaborates on the concept of network externalities and contributes by extending the research on the effects of network externalities on firm strategy by empirical investigation. An investigation of the diffusion of digital television is of critical importance to the broadcasting and television industry in developed market economies. In addition to economic issues, the success or failure of the new technology will also have a wide impact on culture and society as a whole. A better understanding of different rationales and their market consequences will advise the business community and policy makers in their decision-making. The data used combined press releases, trade journals, internet discussion forums, stock market information, and interviews.

1.2 Research problem

Some of the few contemporary empirical studies investigating firm strategies in the network externality context have suggested that the creation of a viable installed base of customers and complementary products is crucial for a firm's success (e.g. Schilling, 1999; Gallagher & Park, 2002). Economists have also predicted that a market with significant network externalities will often act speculatively, helping the first-mover firm but destroying others (Besen & Farrell, 1994). Taking these propositions together, a rational challenger would quickly and decisively build its own network, while the other firms should response to them rapidly, or even pre-emptively. This implies a very dynamic, or even chaotic market development, where every firm has to outpace others.

There would be serious consequences if this were to fully be the case. However, there are some serious gaps in the network externality work, which call into question the validity of the advice. It has been suggested that the previous work has not been able to provide an understanding of the relative importance of various factors in competition (Suarez, 2004), the relationships among different type of participants (Gupta et al., 1999; Venkatraman & Lee, 2004) and the nature of their performance (Majumdar & Venkataraman, 1998; Gallagher & Park, 2002). Kauffman and Walden (2001) describe that "...there is a need for additional research on where network externalities exist and how they affect the actors involved" (Kauffman & Walden, 2001).

The criticism above aims to highlight the ambiguity of the factors affecting firms, especially when there are many kinds of participants. Relationships between different types of firms may add a new dimension to competition. There is no clear comprehension of how firms act and react in networked competition. The interaction of multiple, overlapping networks is a major but neglected area of study (Powell et al., 2005).

In summary, I suggest that there is not a sufficient understanding of what factors are guiding a firm's competitive behaviour, how firms actually act, and how they react to other firms' actions when there are significant network externalities present. This further implies that there is no clarity about the outcomes of the competitive actions

and reactions. This dissertation attempts to fill the gap by developing a model and an explanation of firm strategies in the network externality setting that utilises previous theoretical work and my subsequent case analysis. The research problem can be defined as a question:

What are the drivers affecting a firm's competitive behaviour in a network externality context, and what are the firm and aggregate level consequences of these actions?

1.3 Research objectives

The research objective is to investigate a firm's competitive behaviour, a task that is approached sequentially. The first objective is to understand the setting in question. The point of departure is the concept of network externalities. Network externality is a term for a particular phenomenon, as well a stream of research investigating and theorising about it. Originally, economists and scientists studying industrial organisation observed network externality. The economists' tradition was focused on the macro-level consequences of network externalities, whilst research in the fields of industrial organisation and financing focused on the causes of the phenomenon (Economides, 1996). Much of the work in a similar context has been theoretically approached within the framework of economics, leaving limited attention on empirical examination (Schilling, 2002). In order to comprehend the discussion about network externality, a literature review is conducted using both bibliometric methods and more traditional qualitative literature research. The objective is to describe how the field of network externalities is defined in the most central books and articles, to understand their core ideas and findings, to find out how the research topic links to other relevant scientific discourses, and to review two relevant theoretical research approaches; the evolutionary perspective on economics, and population ecology. The effort also produces a conceptualisation of different types of actors and their relationships. The objective of the nomological map is to crystallise the theoretical insights found in the literature review. The nomological map acts as a theoretical case (Yin, 2003), providing guidance for additional research review and empirical examination. A separate, methodological objective that is approached in the first sections of the dissertation is to offer one way to conduct an extensive bibliometric study.

The second major objective is to review the literature related to the evolutionary perspective on economics, and to population ecology. I introduce theory-derived mechanisms of positive and negative feedback, with their reasoning and implications. This discussion acts to focus the empirical investigation.

Thirdly, a case study is conducted to empirically investigate real-world firm actors and their observable strategies. The case study offers a description of the behaviour of different kind of firms and customers, and their interactions. Qualitative and quantitative data is used. Different analyses of firms' actions are used to evaluate their behaviour and its drivers, and firm- and aggregate-level consequences. The objective is to describe how the competitive events and processes occurred.

Finally, I evaluate how the findings relate to existing theories. The objective is to link the empirical case and the theoretical case, to revise the nomological map, and to elaborate upon how the key mechanisms work. The discussion covers the applicability of the network externality concepts, and theoretical work on the evolutionary perspective in economics and population ecology. The section also covers managerial cognitions, a framework emerging from the findings, which is not covered in the review section.

1.4 Research approach and methods

Network externalities and evolution use concepts that are facets of the same phenomenon (Suarez, 2004). Even with this relatedness, there are no clear predecessors using evolutionary approaches with the network externality concepts and context. Most of the concepts in the dissertation have originally been developed by network externality theorists, while empirical attention will be focused on dynamics investigated according to the traditions of the evolutionary perspective on economics and population ecology.

One of the objectives of the dissertation is explanation building, for which a single-case method is usable (Yin, 2003). The object of analysis is firm strategy, which is observable to the public as actions and news events (VandeVen, 1992; Das & Van de Ven, 2000). Two major concerns have been separating 'noise' from the actual phenomenon, and finding unbiased and reliable data. To overcome these problems I

initially relied on unobtrusive data-gathering methods (Golder & Tellis, 1993; Tellis & Golder, 1996; Gallagher & Park, 2002). Interviews were then used for further data triangulation in order to check validity (Jick, 1979; Cunningham, 1997; Yin, 2003).

Both qualitative and quantitative data were used to overcome the small number of observations and observed organisations, and as a way to add richness to the analysis (Barron, 1998). The investigated data objects are press releases, trade magazines, and stock market information (mostly in electronic form), and interviews. The nomological map derived from the literature is revised to reflect the findings from the case (Yin, 2003).

The literature section is built on the quantitative bibliometric work, whilst acknowledging the limits of this approach. A methodological objective, which can be judged to be a by-product of this research process, is to demonstrate a logical process for using the bibliometric method in literature survey.

The investigation is done under the premises of (critical) empiricism, as reviewed by Jensen in the work of, e.g. Roy Bhaskar. These premises are, firstly, ontological realism, which assumes the existence of reality as limit condition, or regulatory ideal; secondly, epistemological relativism, which assumes that knowledge depends on a reiterated sequence of perceptions, cognitions, and inferences; and thirdly, the exercise of judgmental rationality in science. The last point emphasises that after continuous comparisons of alternative accounts of reality, the scientists and scientific field ought to end with fallible judgments about what to do next (Jensen, 2002). For a realist, causal laws are separated from patterns of empirical events, and regularities are insufficient for the identification of a causal law. The role of the social scientist is to construct the conditions wherein actual domains can be merged with the real domain. Explanatory idiographic studies are “epistemologically valid, because they are concerned with the clarification of the structures and their associated generative mechanisms, which have been contingently capable of producing the observed phenomena” (Tsoukas, 1989).

The research process has used several modes of inference. Deductionist inference is the explicit model of reasoning used in evaluating the nomological maps. My research project originated when I was puzzled by these phenomena, having myself worked in

the same industry. This suggests that induction contributed to my pre-understanding of the problem. Forming maps and modifying explanations are abductions as they involve creating new rules, explaining why particular facts have been encountered (Jensen, 2002).

1.5 Terminology

The terminology in this dissertation consists both of terms widely used in management literature, and concepts that are more closely related to economics or communication studies. There follows a brief discussion of the basic concepts, while those key concepts closely linked to their respective theoretical framework are defined and discussed in the literature review.

1.5.1 Networks

A network is a composite of actors and a pattern of relationships that tie them together (Iacobucci & Hopkins, 1992). More formally, networks are composed of links that connect nodes, which are either one-way or two-way networks. In two-way networks the end-nodes (A, B) are allowed to connect (AB and BA). In a one-way network, there is only one direction of flow (Economides, 1996).

Physical networks include communication and transport systems (Katz & Shapiro, 1985). A 'virtual' network (Katz & Shapiro, 1994), or 'hardware-software' (Katz & Shapiro, 1985) describes a system of linked durable goods with interdependent demand. 'Virtual,' or 'hardware-software' networks can illustrate communities of consumers (Brynjolfsson & Kemerer, 1996). For example, Gandal (1994; 1995) used this paradigm when studying the users of a file compatibility standard. A network may include both firms and persons, typically end customers (Arthur, 1996).

In management literature networks describe several aspects of product-consumer relationships, and inter-firm or personal relationships. Since the 1980's firm networks have been widely studied as a tool for managing environmental uncertainty and satisfying resource needs (Gulati & Gargiulo, 1999). In his article on embeddedness in social relations, Granovetter (1985) clarified how personal relations and social networks create trust and discourage malfeasance. Jarillo (1988) conceptualized strategic networks as a mode of organisation. Participation in a strategic network is

seen as a managerial action to position a firm competitively in a market. Firms involved are seen as distinct, independent, but related, with a central 'hub' firm as a leader and creator. For Jarillo (1988), establishing a strategic network gives a possibility to organise more effectively by lowering transaction costs.

Podolny and Stuart (1995) and Podolny et al. (1996) use a technological network to describe the constraints on a firm, and to conceptualise organisation-specific niches. In technological networks the nodes are technological innovations, and the ties represent commonalities linking innovations to their antecedents. The network has an explicit time dimension. A network as a governance form of organisation is "any collection of actors that pursue repeated, enduring exchange relations with one another and, at the same time, lack a legitimate organisational authority to arbitrate and resolve disputes that may arise during the exchange..."(Podolny & Page, 1998).

In the present study, the term network is used conceptually in accordance with Katz and Shapiro (1985; 1994). The term comprises both physical and 'virtual' networks. The Podolny and Page (1998) definition of network organisation is similar, except for the inclusion of customers. In this study, the network consists of firms, their products and services, and consumers, in exchange relations. Different suppliers provide a total product offering. The offering links suppliers and consumers. A firm, its products, or a consumer, can be involved with one or several networks, or be an outsider to the network.

1.5.2 Network externalities, or network effects

Network externalities, or network effects, model the benefits to a customer of joining a wide network. Rohlfs (1974) introduced network externalities in an article on interdependent demand for communications services. In this example, the number of telephone owners in a telecommunications network directly influences the product's utility. A rising number of customers increased the value of the network for each participant (Rohlfs, 1974; Katz & Shapiro, 1985). An indirect network externality arises in a situation in which the demand for a focal product is affected by the availability of its complementary products (Katz & Shapiro, 1985; Katz & Shapiro, 1986a). Liebowitz and Margolis argue that indirect network externalities describe the market situation poorly. Often, the reason for network growth is not due to

externalities, but to technological progress which is lowering the costs of inputs (Liebowitz & Margolis, 1994, 1995). They also discuss the different implications of terms ‘network externalities’ and ‘network effects’, which are both used. Due to its popularity, the term network externality/externalities is primarily used here. There is a wider discussion of network externalities in the literature review.

1.5.3 Market

Market boundaries have been widely investigated using several frameworks. According to Geroski (2001), economists consider products that have a high cross-elasticity of demand as belonging to same markets; a quite narrow definition (Geroski, 2001). Carroll and Hannan (1995) state that organisational ecologists view the market as a socially constructed phenomenon, and that all of the potential competitors are included in the population (Carroll & Hannan, 1995). The populations can be defined in the context of the particular research interest (Hannan & Freeman, 1977). The socially constructed boundaries are result of firms observing each other’s actions and defining their positions in relation to each other (Porac *et al.*, 1989; Porac *et al.*, 1995). Researchers in management literature tend to describe the market of a particular firm, which is consistent with population ecology (Geroski, 2001). In this study, I follow the management and firm strategy literature tradition that has is especially concerned with firms and their relationships. Baum and Korn (1996) described their approach as being one in which “every firm in an industry is conceived to occupy a potentially unique market domain – defined by activity in various product-client markets – that delineates its locations in a multi-market resource base” (Baum & Korn, 1996). In the case study of this work, United Kingdom viewers demand different products and services from the television industry. The demand of final products and derived demand is affected by the different participants, and the markets are not independent from the firms operating there. Some participants are producers as well as traders and consumers in the market (Geroski, 2001).

1.5.4 Technology

Technology is understood as artefacts and knowledge that together serve a functional need (Das & Van de Ven, 2000). The evaluation criteria for a particular technology have traditionally been seen as being independent from the actions of the firm (Das &

Van de Ven, 2000; Dickson et al., 2001; Lee & O'Connor, 2003). This view stresses the product related aspects (Lee & O'Connor, 2003) or technical features (Das & Van de Ven, 2000). On the other hand, technology as a social construct is evaluated through the interactions of the firm and other participants (Das & Van de Ven, 2000). The latter perspective, emphasising the institutional, or extrinsic aspects (Das & Van de Ven, 2000; Lee & O'Connor, 2003), is also followed in this study.

1.6 Limitations of scope and key assumptions

This dissertation focuses on firm strategies and actions at the time of the commercial introduction of a new technology. Suarez (2004) divides competition for technology dominance into five phases. The first milestone, 'R&D build-up,' denotes the beginning of the competition, with an organisation pioneering applied research and development. The second phase, 'technical feasibility,' begins when the first working prototype emerges. 'Creating the market' starts from the launch of the first commercial product, and 'decisive battle' begins when a clear early front-runner appears. The start of 'post-dominance' denotes the time when one alternative becomes a dominant design (Suarez, 2004). Following Suarez (2004), the dissertation focuses on phases termed 'creating the market' and 'decisive battle,' and the emergence of 'post-dominance'.

The empirical context is the first years of digital television in the U.K. consumer markets, which should act as a representative example of network externalities (particularly indirect network externalities). Information technology is a widely used scope when investigating network externalities (Shapiro & Varian, 1999a). The chosen empirical scope imposes certain biases and might set limits on the wider application of results. The possibilities to participate in the adoption of innovation might be more limited in the television industry, because of the worldwide economic difficulties in television markets during the period in which the research was set. The broadcasting and television industry is also characterised by significant regulation, which affects competition in various parts of programming and distribution.

While the dissertation provides a discussion of the importance of complementary products and services, a more in-depth investigation is limited to the major companies. The investigated time period is relatively short, whereas evolutionary and

ecological framework approaches have typically investigated longer time frames (e.g. Aldrich & Pfeffer, 1976). However some proponents of these frameworks do claim that qualitative inspection and shorter periods are suitable when investigating particular phases in organisational development (see e.g. Barron, 1998).

The unit of analysis is firm competitive strategy, manifesting as patterns of observable actions (VandeVen, 1992; Das & Van de Ven, 2000). Observations are carried out by examining retrieved firm announcements and reported news stories. The method is chosen to give a reliable account of the facts as they happened. The focus is on events evidenced by the public outside of a particular organisation. There is bias in this method, because there is more information available about firms in which the public has a wider interest. These include large companies, publicly listed companies, and companies with a state interest, while small firms receive less attention. Retrospective interviews were conducted to correct this bias and to complement the case description. Their expert opinion provided a narrative that focused on the most intensive phases of competition. Various sources of information were used during data gathering in order to provide triangulation. Efforts to combine different methods and data sources do have the drawback of drawing resources away from a greater depth of analysis or a superior command of methodology.

1.7 Structure of the dissertation

This first chapter sets the research question, and clarifies the central concepts and methods in this study. Theoretical and phenomenon related literature will be reviewed in chapter 2. The review of the network externality phenomenon uses bibliometric methods in describing the discussion relating to network externality, and then maps the discussion into the wider framework. The insights from the previous research will be further elaborated into a nomological map. The research approaches of the evolutionary view of economics and population ecology will be further discussed. Chapter 3 clarifies the research setting and methods. Chapter 4 is an empirical account of digital diffusion in the United Kingdom, and is followed by a summary of results in chapter 5. Chapter 6 provides a more elaborate synthesis, including a nomological map of the phenomenon. A discussion of the contributions of the study and suggestions for further research conclude the dissertation.

2 LITERATURE RESEARCH

This chapter aims to map and review the relevant research. A methodological objective of this dissertation is to suggest a new bibliometric approach for literature reviews. The methodological contribution lies in a stepwise, unobtrusive mapping of core literature within its wider context. The benefits and drawbacks of the method used are discussed in this section and the appendices. The five stages of the literature research consist of both qualitative and quantitative elements.

Firstly (chapter 2.1), the bibliometric method is presented. The bibliometric method produces an identification of the de facto structuring of the discourse related to the phenomenon (Parvinen, 2003). Most of the information about the data retrieval processes and methodological details is left to the appendices.

Secondly (chapter 2.2), I conduct a bibliometric mapping in order to link research on network externalities to its wider context. Co-citation relationships emerge between the network externalities discussion and other theoretical frameworks in social sciences. The stage produces an illustration of how the network externality discussion is connected to the wider discourse on firm and organisation. Visualising the links provide information about the relative isolation of network externalities and other fields. The scientific map suggests that studies on innovation and market structure act as a figurative intellectual link or bridge between the network externality group and the wider community.

In the third stage (chapter 2.3), an attempt is made to map the discourse around network externalities. The mapping of the network externality discussion is done without theoretical preconditions using bibliometric tools, and is focused on the phenomenon-related work. The retrieved documents are clustered, and the contents of those clusters are described.

Fourthly (chapter 2.4), I will explain the insights of the retrieved major documents with some newer research. The work on network externalities is summarised, and visualised in a nomological map. The map is a conceptual framework to guide my empirical examination later in the study.

In the fifth stage (chapter 2.5), two theoretical frameworks investigating positive and negative mechanisms are reviewed. The evolutionary perspective on economics (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982) and population ecology (Hannan & Freeman, 1977; Carroll, 1984; Hannan & Freeman, 1984) emerged in the first section of literature research, and have the potential to guide the following case study. There is an overlap between the insights of the network externality section and the presentation of these theoretical frameworks. The frameworks advise on what type of information to look for in the empirical examination.

The structure of the literature research aims to give the reader a view of the history of the assumptions and definitions of the topic, and also to serve as an attempt to justify the later choices made in the dissertation (Hart, 1998). With this procedure I have wanted to describe the substantive research, and its relationship to the selected theoretical frameworks. To restate in metamorphic terms, I use the concepts offered by the substantive researchers as labels or boxes, which are later filled with the ideas generated by the theoretical frameworks.

2.1 Bibliometric method

In order to carefully map out the scientific landscape, this literature research uses a stepwise procedure. This chapter describes the methodology of bibliometric research, which has been widely used in social science (Ratnatunga & Romano, 1997). Bibliometrics, or bibliometric research processes, uses information on authors' names, origins, titles, publication outlets, dates, and other quantitative information to re-structure this data for different purposes (Weinstock, 1971). The importance of the method in structuring scientific discussion has risen with the general expansion of research (Oliver & Ebers, 1998). Following most authors, the words 'reference' and 'citation' are used here interchangeably (Osareh, 1996a).

The most popular affiliations or cited documents can be described as the major building blocks in the discourse. Citations can be used as indicators of present and past activity in discovery and creativity (e.g. Garfield, 1955; Garfield et al., 1964; Small, 1973; Garfield et al., 1978). An approach called citation analysis is a bibliometric method that uses reference citations found in texts (e.g. Garfield et al., 1978). The existence of a citation is taken as a measure of the significance allocated to

the reference or its author. A citation can be thought of as a symbol that an author wants to give to his written idea (Small, 1978).

Co-citation is a link between two documents that is created by later documents. The cited documents are closely related to each other if they are cited in the same articles (Small, 1973; Cawkell, 1976; Garfield et al., 1978). Different patterns of citations may be seen as different discussion streams. Co-citations emerge and are later superseded by the actions of a community of specialists who are themselves writing on the matter (Garfield et al., 1978). The changing linkages can illustrate the changing pattern of scholarly activity (Small, 1973; McCain, 1986).

Research published in a valued scientific journal is evaluated as having more weight in the scientific discourse than that which appears in more practitioner-orientated journals, or in journals held in lower esteem (e.g. Parvinen, 2003). Therefore, citations in an article from an appreciated outlet help to form a better pattern of high-level scientific discussion than citations from the entire publication population.

The use of citations as a basis for studying the state of science has faced some criticism (for reviews of this topic see e.g. MacRoberts & MacRoberts, 1989; Osareh, 1996b). There are concerns relating to bias in citing, the measurement of only publicised articles and books, variations in citation rates, and the technical limitations of citing (MacRoberts & MacRoberts, 1989). Co-cited documents differ from many other networks, as their interaction does not continue. Information is shared in the citer articles, but the amount and quality of information is unknown. The citing author may have referenced in a positive or negative sense, whilst still appreciating its value in their article (Gmür, 2003). The growth of databases may have reduced the problems of Roman script, and especially English bias, which had earlier received much attention (e.g. MacRoberts & MacRoberts, 1989). Defenders of citation analysis have countered this issue by arguing that they represent 'random noise' with only a minor effect (Cawkell, 1976). Additionally, the size of data warehouses has grown in recent years, due to cheaper and more efficient technology.

2.1.1 Social network analysis in bibliometric research

Social network analysis is an aid to analysing actors and their relationships in a networked system. It studies the attributes of pairs of individuals, including distances and similarities (Borgatti & Everett, 1997). Social network analysis provides a set of mathematical and visual techniques for analysing and visualising the structures of interactions among agents (Borgatti & Everett, 1997; Venkatraman & Lee, 2004).

In bibliometric studies, social network analysis tools can indicate the different roles of documents in the network externality discourse. In this context, the nodes are cited documents and links are the citing articles. Social network analysis uses bibliometric data to also describe the importance of an individual document, author, or discipline. Citation analysis has been used with the tools for social network analysis in the social sciences (e.g. Oliver & Ebers, 1998; Phillips & Phillips, 1998; Parvinen, 2003).

The questions of an individual's centrality are of major importance in social network analysis. Centrality can be motivated by the idea that an individual close to others will have access to more information, status, power, prestige, or influence (Freeman et al., 1991; Friedkin, 1991), or by the idea of centrality as betweenness on the paths of communication (Freeman, 1977; Freeman et al., 1991). The centrality measure is also a descriptive property of the network (Stephenson & Zelen, 1989), and is applicable when describing the structure of discourse, even with the difficulties of interpreting the results.

The social network analysis method applied with bibliometric analysis is explained in more detail in Appendix 7.3, 'Details on using social network analysis'.

2.1.2 Bibliometric clustering

Clustering a scientific discussion highlights its intellectual structure (Culnan, 1987). In clusters, the order of documents is re-arranged so that the most similar documents appear closest. More generally, clustering is an unsupervised classification of patterns (data items, observations, feature vectors) into groups. The methods are widely and differently used (Jain *et al.*, 1999).

The major approaches are ‘bottom-up building’ of hierarchical agglomeration, and the ‘top-down splitting’ of iterative partitioning. In the former, pairs are gradually joined in larger clusters, and it is this approach that has been the more popular of the two in use with co-citation data (McCain, 1990). Among the approaches, there are several methods for providing clusters, and consistency and interpretability can be seen as the most important factors in deciding particular method (McCain, 1990). Average link method was used for further analysis, because it produced clusters more continuously than the other hierarchical methods. Clustering methods are explained in more detail in Appendix 7.2.

2.2 Network externalities as part of wider discussion

The network externalities discussion is part of social sciences. In this chapter I will conduct a bibliometric study to map the network externalities topic in its wider context. The chapter attempts to show and understand how the network externality discussion is related to scientific streams on firm strategy and organisational science. Firstly, I describe the idiosyncrasies of the data retrieval process. This is followed by a mapping of the scientific texts, and a description of the groups containing texts that are related to each other by co-citations. Data retrieval process on this bibliometric study is found from Appendix 7.5.¹

As the aim was to locate the network externalities discussion in its broader context, all of the journals published in 2003 in the ISI Web of Science Social Science Index were used for data mining. A search was made to find all articles citing a particular research article or a book, which represents a scientific framework.

Figure 1 illustrates how the network externalities discussion relates to other streams of non-economics research. The scientific map covers many streams, and therefore the associations are different than in more limited discussions such as network externality discussion. The group limits have been drawn subjectively, consulting standard teaching material e.g. reading lists of strategy courses.

¹ This bibliometric study was conducted after the bibliometric study on network externality discussion, which has some implications on the data retrieval procedure. I have presented the wider discussion first, as an attempt to serve readers by providing a prologue to network externalities.

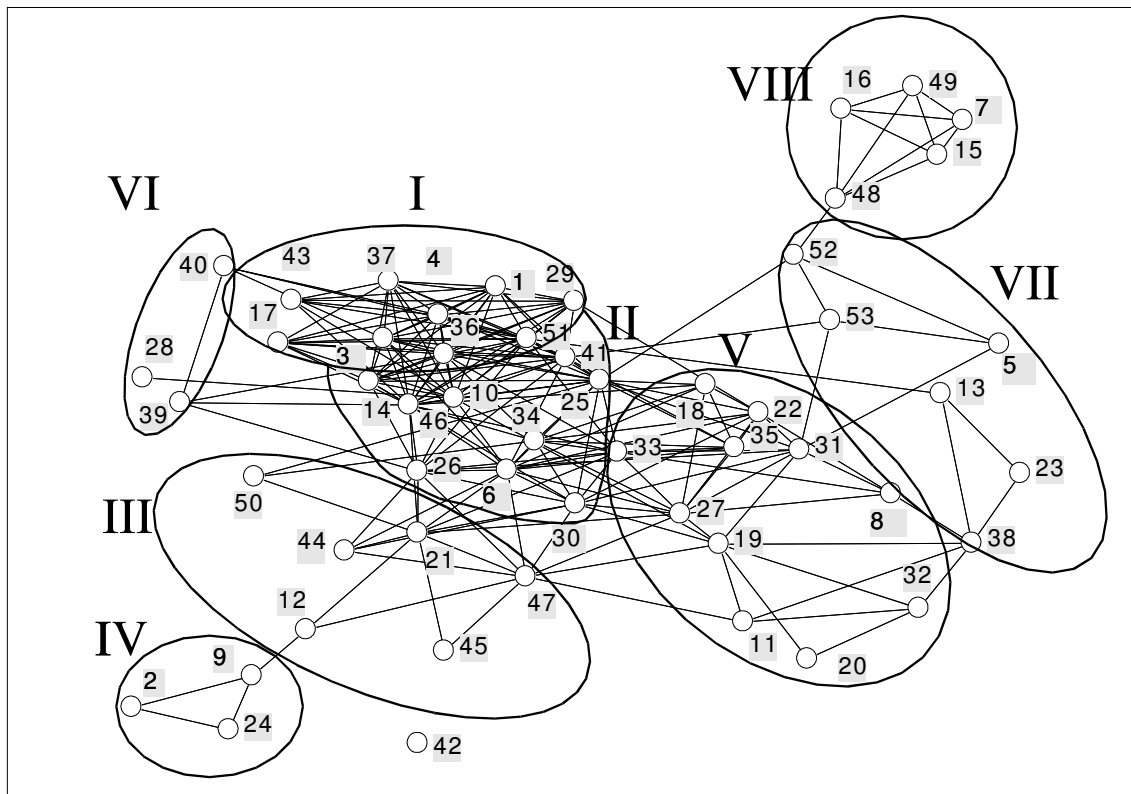


Figure 1 Streams of discussion related to network externalities

2.2.1 Group I

The group includes some of the most influential articles on the resource-based view, including Barney (1991). The documents have dense links between them. These documents investigate how firms develop their competitive advantages by nourishing and leveraging their idiosyncratic competencies and resources whilst matching their competitive environments. The documents include also Barney (1986), Penrose (1959), Wernerfelt (1984), Amit (1993), Peteraf (1993) and Dierickx and Cool (1989). This group connects well to all of its neighbouring groups, indicating its significance in the larger discourse. A visual inspection suggests that other groups could be regarded as outer-circles of this influential group. The resource-based view could be characterised as being the core of the literature related to the network externality discussion.

2.2.2 Group II

The second group is a dispersed extension of the RBV approach, discussing how knowledge related issues create a valuable asset, sometimes in rapidly changing environment. The group includes documents on the knowledge-based view, social capital, and dynamic capabilities with performance implications. These documents have often been co-cited with RBV texts, but also with members of groups three and five. Some of the most prominent articles are Cohen (1990), Prahalad (1990), March (1991), Nonaka (1995), Kogut (1992), and Teece (1997).

2.2.3 Group III

Between the two RBV associated groups and the network externalities documents is group three. It discusses innovation, market structure and macro level change. In addition to Tushman and Anderson's (1986) 'Technological Discontinuities and Organisational Environments', the group consists of, e.g., Schumpeter (1934) and Henderson and Clark (1990). Henderson and Clark (1990) is co-cited at the chosen level with all of the other members, while the others are co-cited less with the group members.

2.2.4 Group IV

The active network externality authors are located on the bottom-left corner (group four). The new network externality group is distinctive from other groups in this bibliometric effort. The distinctiveness in relation to other fields is noticeable, especially when the discussion seemed dispersed in the earlier examination. Katz and Shapiro (1985) acted (article ID 24) as an original proxy for the network externality discussion, but received close co-citation links with Arthur (1989) and David (1985), forming a single group. The graph suggests that somewhat different fields have cross-fertilised the co-citers' work. These articles cover complexity in network markets, and especially increasing returns and path-dependence of innovations.

2.2.5 Group V

The fifth group investigates learning, adaptation, and selection in and among organisations. It has a more descriptive approach than the second group, having links especially to groups two, three and seven. Members are documents focusing on

organisational learning, evolutionary economics, and population ecology. The group members attach to the previous group, especially Nelson and Winter's (1982) 'Evolutionary Theory'. Other documents in the group are far less cited e.g., Cyert and March (1963), March (1958), Hannan and Freeman (1984, 1989) and Nonaka (1994).

2.2.6 Group VI

An outlier group on the left, group number six discusses the implications of industry structure for firm strategies. The group has an emphasis on industrial organisation economics e.g. Porter's (1980) 'Competitive Strategy' and competitive dynamics. It includes Lieberman and Montgomery's (1988) 'First-Mover Advantages'. The lack of co-citations at the level seen in the graphical presentation would have kept the latter from the more coherent stream. Similarities occur only at lower levels.

2.2.7 Group VII

The seventh group consists of two co-cited triangles of documents, discussing power, control, uncertainty, and trust. Transaction cost economics, agency, and power dependence theories are streams of discussion that are represented in the group. Pfeffer and Salancik (1978) was the most cited document. The documents located in the periphery only have strong co-citation links to members of one other cluster, except Williamson (1975), (1985). Another sign of possible instability of the group is inclusion of the methodological article of Eisenhardt (1989) amongst the most popular documents in the cluster.

2.2.8 Group VIII

The top-right corner consists of research that studies different features of how embeddedness in social structures affects economic actions. Uzzi (1996, 1997), Granovetter (1973, 1985) and Coleman (1988) compose this tightly knitted group. The group is not strongly linked to the other groups.

2.2.9 Summary of the related research mapping

The groups and the map in the previous chapter illustrate the core-periphery type structure of the related research discourses. The network externality discussion is in the periphery if we evaluate non-economic social sciences. The core of the wider

discussion is the resource-based view group to which the other fields connect. The RBV links to the field of network externalities via groups II, III, and indirectly via V. Evaluating the texts by groups, the path can be followed from one stream to another. These groups focus on firm resources, innovation, market structure, knowledge, learning, adaptation, and selection, all of which have something in common with the network externalities.

2.3 Mapping network externalities discourse

The second, and more focal bibliometric study is used to search for relevant literature about the network externalities phenomenon. The section first describes the retrieval of data. After being identified, the most important documents in the network externality discussion are clustered. The core of the network externality discourse is located, in addition to other distinctive clusters. After clustering, the reader is introduced to the insights provided by the clusters. The aim is to describe the structure and content of the extant literature, and finally to summarise the insights. Emphasising the most cited scientific works in this discourse is motivated by the assumption that they will have the power to intellectually structure the discussion.

2.3.1 Manipulation of data

Bibliometric analysis was conducted to explore the written and published scientific discourse on items covered by this study. The main emphasis is to find and classify the articles and books that have been seminal for researchers, and to describe the advancement of the discussion, especially in the field closest to strategy research.

The ISI Journal Citation Report was primarily used for journal selection, with the evaluation of journals carried out using their impact factors. The service claims that this measure can be used to evaluate journal's relative importance compared to other journals in the same field (<http://www.isinet.com/>).

The evaluation included journals rated in the top 20 ISI Journal Citation Report of 2002, in the areas of economics, management, and business. In order to check the reliability of journal selection, some more recent journal-ranking related articles and research was consulted (Siggelkow, 2001; Parvinen, 2003). Following Parvinen (2003), a procedure was made to ensure that the most appreciated journals were

included. The additions were based on information from a readership survey amongst the faculty of prestigious U.S. business schools' strategy, organisational behaviour and economics departments (Siggelkow, 2001). As a result, 66 journals were included.

Two article searches were conducted using the combined journal list. A search was made to find articles concentrating on the topics of network externalities, published in the above journals in 1986-2003. The articles were retrieved from the Social Sciences Citation Index of ISI World of Science. As the aim was to analyse the discussion of network externalities, the search words were chosen accordingly. The search words were 'network externality', and 'network effect,' including plural forms. The data retrieval included 120 articles citing 3955 other documents. After bibliometric procedures, there were 108 articles citing 103 influential texts. A more detailed view on forming the data corpus is given in Appendix 7.1.

2.3.2 Structure of the network externality discussion

This chapter describes how bibliometrics and social network measures portray the network externality discussion. The bibliometric results are classified by reading the particular documents.

Some visible patterns are found when analysing the network externality discussion. The core of the network externalities discourse is seen in Figure 2, mapping information of co-citation data².

²The Netdraw procedure of Ucinet 6 was performed to illustrate the position of articles. The size of an individual edge (article) reflects the number of absolute number of citers the article possesses. The labels are identification numbers for the articles. The software positioned nodes by their node repulsion, geodesic distance, and line.

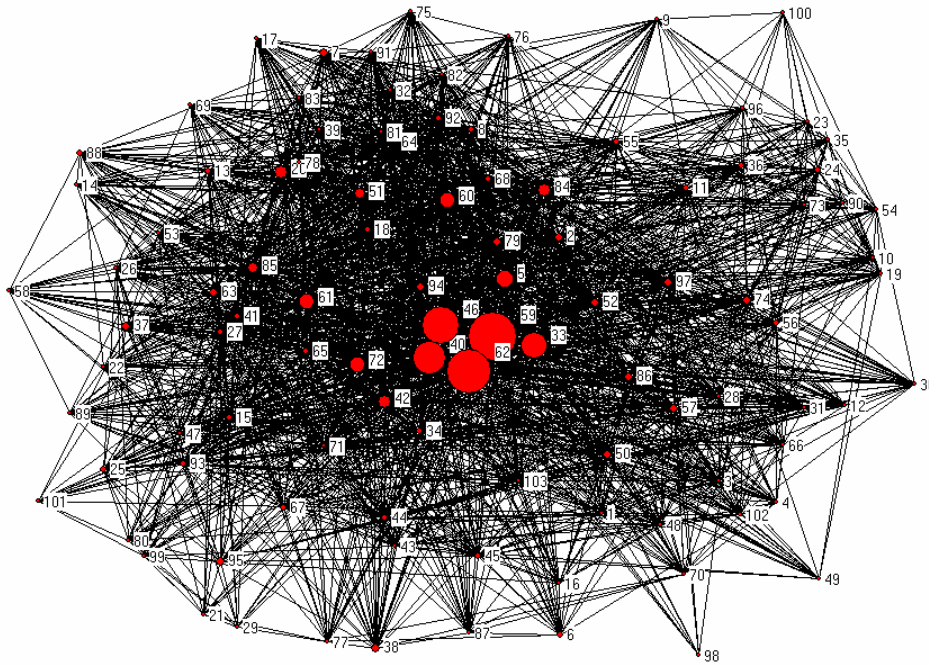


Figure 2 Co-citation map of 103 articles

The most dominant articles in the discussion are articles number 40, 46, 59 and 62 in the centre of the picture.³

The most important articles are from two groups writing in economics journals. Michael Katz and Carl Shapiro wrote their ‘Network Externalities, Competition and Compatibility,’ for the American Economic Review in 1985 (article id 59), and their ‘Technology Adoption in the Presence of Network Externalities,’ was published in the Journal of Political Economy in 1986 (id 62). The RAND Journal of Economics published ‘Standardisation, Compatibility, and Innovation’ by Joseph Farrell and Garth Saloner in 1985 (article id 46) followed by their ‘Installed Base and Compatibility: Innovation, Product Preannouncements and Predation’ for the American Economic Review in 1986 (id 40). In addition to having similar a citer

³ Articles number 40, 46, 62 were partly overlapping and therefore moved slightly to get number 40 visible. Articles 33 and 93 are positioned close may have a similar citer profile, but have not been so widely referenced. Therefore, they are not as influential as their more referenced network neighbors are.

profile, they are the most cited articles in the search. This can be observed from the graph, as their corresponding circle symbols are much larger than the others. These articles set up the network externality discussion, while they themselves share some common ancestors, e.g. Rohlfs (1974).

Clusters in the network externality discussion were found with the major different methods. The same core articles establishing the concepts in the discussion appear in one cluster irrespective of method.

The average-link method suggested eight clusters (A to H), where each cluster was separable at certain similarity level. Some clusters are not as distinctive, and there exists some overlap between clusters. Clusters E to H seem to have their respective cores and peripheries, or dual cores. Further sub-clustering was then tried by lowering the similarity level. The sub-clustering was supported by qualitative inspection. On the other hand, clusters A to D had a shared emphasis on economics, and the clusters could have merged on grounds of content⁴.

Identifying and reading the most important documents in the cluster provided information for describing the content of the cluster. Here, the documents with high centrality were considered as having more impact on the discourse. The centrality measures were Freeman's betweenness centrality (Freeman, 1977), information centrality (Stephenson & Zelen, 1989) and number of citers⁵.

A new reading provided information about the content of the group documents. Often documents in a particular cluster seem to share certain themes, rather than belonging to a specific scientific framework. Certain overlapping categories emerged to the investigator after an iterative reading of the highly valued documents. Descriptions of the different clusters will follow.

The importance of a document is evaluated in relation to this discourse only. Several important articles from diverse scientific fields received only a few citations in this

⁴ Four clusters (E-H) could have been divided with lower similarity levels. Qualitative reading of the documents supported the possibility of sub-clusters for clusters E and F. Combining the ideas, the new grouping would have produced seven groups: A-D, E.i, E.ii, F.i, F.ii, G, and H.

⁵ There is no clear theoretical guidance as to the relative importance of different centrality and citation count measures. The documents are in Table 21 in Appendix 7.3, in which the documents passing any of the thresholds are in bold letters. There were 46 documents that passed the threshold, and these were further examined.

bibliometric study. In evaluating the discussion about network externalities these are not judged to be important in this context. For example, a classic of a different discussion belonging only vaguely to the network externality discussion had only a marginal impact on the cluster in this effort. This has implications for the classification.

2.3.2.1 Economics clusters from A to D

The content of clusters A to D suggests that they could be merged together. A low impact cluster A is located in the field of economics and industrial organisation with no major impact on the wider discussion. None of the eight documents in the cluster passed citation count or centrality thresholds. Common themes are interactions between firms, economics of innovation and planned obsolescence. Theoretical concepts and modelling are used to investigate the subjects. The document with most information centrality in this cluster is ‘Theory of Industrial Organisation’ (1988) by Jean Tirole, while ‘Network Externality, Compatibility Choice, and Planned Obsolescence’ (1994) by J.P.Choi received the most citations.

Cluster B does not have strong input to the discussion. There is an emphasis on issues such as compatibility, bundling, standardisation, and market structure. Theoretical concepts and modelling are used to investigate the subjects. There are seven members in the cluster, and the only influential article is ‘Network effects, software provision, and standardisation’ (1992) by Jeffrey Church and Neil Gandal. By examining the software provision decision of software firms they find that when consumers place a high value on software variety, there is a sub-optimal amount of standardisation by the market. The articles mostly fall into the realm of economics.

The major themes in cluster C are compatibility, standardisation, information, switching costs, and comparisons of product components and systems. The documents develop theoretical concepts and modelling, and they belong to the frameworks of economics and transaction cost economics. This cluster is more important than the other economics counterparts. Five documents exceeded the threshold from this ten-member cluster. The most influential of them is Matutes and Regibeau’s (1988) article ‘Mix and Match – Product compatibility without network externalities’.

Cluster D, with its eight texts, primarily contributes to the development of market structure. The only two influential articles according to measures used are ‘Second-sourcing as a commitment – monopoly incentives to attract competition’ (1988) by Joseph Farrell and Nancy Gallini, and ‘Dynamic Competition with Switching Costs’ (1988) by Farrell and Carl Shapiro. They investigate switching and set-up costs and the implications of overlapping product generations. Economic modelling is the most widely used approach, favouring the merging of this cluster to others in the economics cluster.

2.3.2.2 Cluster E: Network externalities

This is the most important cluster, and the core of the network externality discussion with 16 documents. From these, 13 are appreciated as being influential. Hierarchical clustering suggested that it is quite easy to divide this cluster into two sub-clusters, and this is supported by qualitative analysis. If divided to two sub-clusters, the subcluster E.i would include 10 documents, whilst E.ii, with its more empirical context, would have three documents.

All but one text in sub-cluster E.i is considered influential, and they define the theoretical framework of the discourse. Sub-cluster E.i contains the most influential documents found in the studied discourse, and they lay the theoretical foundation for the network externality research. Articles called ‘Standardisation, Compatibility, and Innovation’ (1985) and ‘Installed Base and Compatibility – Innovation, Product Preannouncements, and Predation’ (1986) by Farrell and Saloner belong to this cluster, as well as articles by Michael L. Katz and Carl Shapiro called ‘Technology Adoption in the Presence of Network Externalities’ (1986) and ‘Network Externalities, Competition, and Compatibility’ (1985). The sub-cluster also captured articles by Jeremy Rohlfs (1974) and Shmuel S. Oren and Stephen A. Smith (1981), which can subjectively be regarded as the most important predecessor articles. Studies in the sub-cluster have used modelling in the economics framework, with anecdotal references to the empirical world, especially telephone networks.

Sub-cluster E.ii is differentiated from the former by having less impact on the discussion, and with an approach that is more empirical. Models are tried using data from colour television, computer software sales, and the diffusion of bank automated teller machines. Although the framework is principally in economics, the sub-cluster

contains pioneering marketing article on diffusion called ‘A New Product Growth Model for Consumer Durables’ (1969) by Frank M. Bass. The most influential document in this context is ‘Hedonic Price Indexes for Spreadsheets and an Empirical Test for Network Externalities’ (1994) by Neil Gandal.

2.3.2.3 Cluster F: Path dependence

Cluster F contains 19 documents, with 13 influential documents. The tree-diagram of the average-link clustering suggests that it could be divided into two groups. The first sub-cluster, F.i, contains nine influential documents dealing with issues of instability in markets, technology diffusion, high-tech market structure, and technological lock-in. The most important article in the sub-cluster is ‘Systems competition and Network Effects’ (1994) by Katz and Shapiro, which compiles the themes researched in the network discourse.

F.ii is a small but influential sub-cluster having four texts, which are respected even more widely outside of the network externalities discourse. In fact, most of the articles do not explicitly investigate network externalities, but concentrate on path-dependent or idiosyncratic progress of a firm or industry. These themes are major streams that can be found in a wider context of research investigating firms in society: the evolutionary model of technological change (Anderson and Tushman, 1990), first-mover advantage (Lieberman and Montgomery, 1988), and firm resources and competitive advantage (Barney, 1991).

2.3.2.4 Cluster G: Collective action

The 14-member cluster G is a group with a strong impact on social sciences, as it studies several aspects of collective action, but with only four influential documents in this context. All of them are part of sub-cluster G.ii, suggesting that G could be treated as one entity. Both sub-clusters possess similarly wide significance for social science, and they have important documents on marketing and organisational ecology. The texts of G.ii investigate issues about how collectives of individuals shape market structure. The influential articles are about increasing returns (W. Brian Arthur, 1989), the diffusion of innovation (Everett M. Rogers, 1962), the evolutionary perspective on economics (Richard Nelson and Sidney Winter, 1982), and threshold models (Mark Granovetter, 1978).

2.3.2.5 Cluster H: Decision making

Cluster H, with 20 documents, is the largest, and has eight documents ranked as influential. The cluster concentrates on decision-making, and could be divided into two, because of the cluster structure. However sub-cluster H.i produces five articles, of which none is influential. H.ii has 15 documents, with eight of major importance. They cover a variety of business strategy issues, with eight influential documents. Documents have a normative tone, as they often offer suggestions to firm managers. There is a belief that a firm's competitive structure is something that a manager can and should act upon. Authors use econometric modelling, or back up their reasoning with anecdotal evidence. The most influential document, 'Technological Discontinuities and Organisational Environments' (1986) by Tushman and Anderson, uses longitudinal data from different industries to validate their claims. Some of the other important contributions include 'Competitive Strategy' (1989) by Michael Porter, 'Profiting from Technological Innovation – Implications for Integration, Collaboration, Licensing and Public-Policy' (1986) by D.J. Teece and 'Inside the Black Box: Technology and Economics' (1982) by Nathan Rosenberg.

2.3.3 Summary of the network externality discourse mapping

The section provided an illustration of how co-citation data about the network externality discourse could produce scientific mapping. Identifying the structure of the discourse produced one very distinctive core. Irrespective of other citations, a researcher publishing an article about network externalities in a scientific journal is more likely to cite the core articles than any others. The network externalities discussion relates most often to the articles 'Network Externalities, Competition and Compatibility' and 'Technology Adoption in the Presence of Network Externalities' by Michael Katz and Carl Shapiro and 'Standardisation, Compatibility, and Innovation' and 'Installed Base and Compatibility: Innovation, Product Preannouncements and Predation' by Joseph Farrell and Garth Saloner.

Figure 2 reveals the most important individual articles, but their key role shadows other contributors and hides the patterns among and between groups of works. As many of the citers cite the core articles, uncovering the more hidden pattern of citations linked to other important articles may be informative. Figure 3 is an illustration produced after the normalisation, showing the clusters linked by their co-

citers. The map offers more information about closeness of different clusters compared to the dendrogram (More details about the procedure in Appendix 7.2).

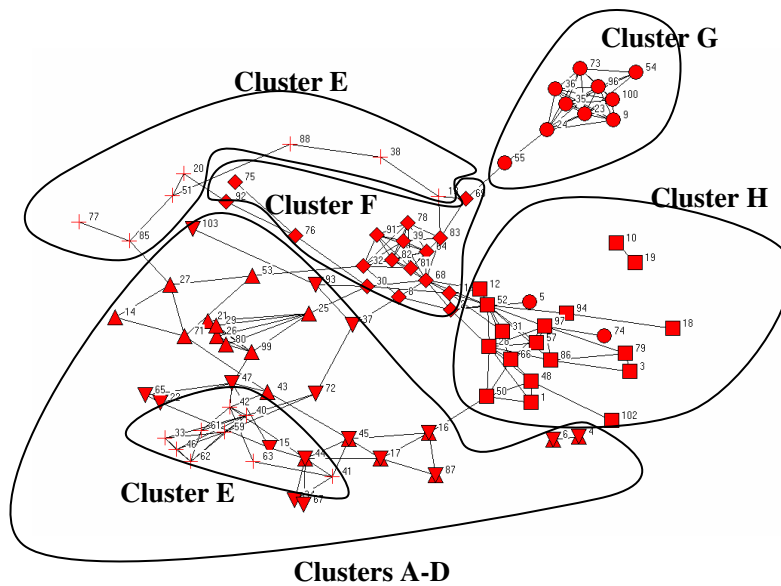


Figure 3 Mapping of the clusters of network externality discussion

Legends: Clusters a and b = triangle pointing upward; cluster c = triangle pointing downward; cluster d = piled upward and downward triangle; cluster e = +; cluster f = diamond; cluster g = o; cluster h = square

Using citation and social network analysis, some further conclusions about the structure of discussions can be made. Cluster E forms the centre of the discourse with the most influential documents in the field. The documents that established the network externality discussion (cluster E) are located in the left-bottom corner of the graph.. As most of the new contributors cite the core articles, the citing pattern of stays similar i.e. they are cited by almost everyone.

In the bibliometric clustering, economics literature dominated the groups from A to E, and they were spread also over remaining clusters. A description of the content in the clusters shows that the economics clusters (A-D) could be merged, at least for the purposes of a non-economics study. This bibliometric effort showed that the discussion of network externalities has been driven by two pairs of economists, and has been largely theoretical in nature. The influential non-economics texts have provided less focused input to the network externality discussion, or they have been

concentrating on issues that are not directly involved with network externalities. The other disciplines have taken an important role in the discussion, as evidenced by the better scores of documents in clusters F (path dependence) and H (decision-making). Articles citing cluster G (collective action) documents do not cite the documents found in the other clusters.

The unevenness and differences among and between clusters are partly due to the small size of the discussion, in which a small number of citers produces less cited core documents. A citation works as a symbol for a shared idea only if there are many citers, because only a few citers may not necessarily cite for the same reasons (Small, 1978). Unstable clustering may reflect not only a mathematical or technical problem, but may imply that the investigated discussion has not been along paradigmatic lines. The bibliometric investigation suggests that network externality discussion is neither well developed nor coherent. The economists have formed the core of the network externality discussion, but studies on path-dependence and decision-making are gaining more popularity. A further examination of the key concepts is required, to shed light on the phenomenon and the discussion about it.

2.4 Insights from the network externalities literature

The present chapter describes how the most influential documents in the network externality discussion view the phenomenon. I present the insights from the most influential documents of the network externality discourse, while attempting to judge their relevance especially from firm strategy point of view. The topics cover the types of network externalities; origins and characteristics of network externalities; and their implications for firm strategies.

The articles chosen for closer inspection represent the most influential cited documents in the network externalities discourse, in the chosen sample of quality journals of economics, firm strategy and management⁶. The established network externalities literature was published some years ago, which is problematic for an extensive literature review. Since I also wanted to include influential new articles, I

⁶ The importance and association of the qualified cited documents to the subject is based on my subjective judgment. I have not included each instance when a citer has cited the documents. E.g. if a cited document is a book, the citers may have referenced with different motives. My reading of the text can differ from the judgments by the citers.

used different approach. In order to be considered as an important recent article, a document had to be published during 1998-2003 in one of the 20 most influential business strategy journals, and cited at least once in addition to authors themselves.⁷. In the articles the use of the concept and empirical domain varies greatly.

The documents are often incommensurable. They include articles and books, and their orientation can be empirical, theoretical or pedagogical in nature. In addition, the focus of an individual document may or may not be network externalities. Moreover, there are documents that do not mention the phenomenon, but that have still been contributing to research around the subject. In the following chapters, books or articles that do not specifically investigate network externalities, but which are important members of the clusters and as such are significant articles in the discussion, are typically described with an expression such as ‘a related article’.

Due to the variety of the retrieved texts, a unified approach is needed to structure the literature review⁸. The bibliometric mapping and the chapter highlighted the major topics in the discussion. Based on these insights I created a nomological map, which serves also as a structure for the review.

2.4.1 Nomological map of network competition

In this chapter, I will summarise the findings from the discussion and explain some of the problems with the network externality research tradition. A nomological map is based on the literature identified in the bibliometric research. The later chapters provide more detailed description of the major concepts and research about them.

⁷ The data is from ISI Web of Science, and details are provided in Appendices 7.1 and 7.4. The twelve recent articles cover economics, marketing, and firm strategy issues. They include modelling with and without empirical evidence, reviews, case studies, and hypothesis deduction with quantitative testing. The retrieved twelve business journal articles represent network externalities in a fragmented manner, as most of the articles cover only part of the phenomenon

⁸ Most reviews give similar treatment on classification, origins, and characteristics of network externalities. These include (e.g. Besen & Farrell, 1994; Katz & Shapiro, 1994; Economides, 1996; Yang, 1997). Their example is not as consistent on firm behaviour, which is the focus of the dissertation. Behaviour, and especially firm strategy in a network environment, has received different treatment in recent studies and reviews. There are examples evaluating firm strategies (e.g. Besen & Farrell, 1994; Katz & Shapiro, 1994; Shapiro & Varian, 1999b) with different motivation and line of arguing. In addition many other retrieved texts refer to firm strategy, especially concerning first mover advantages, and diffusion implications. I have also included more recent, or other closely related articles, when evaluating the insights of establishing literature.

The network externality discourse relies heavily on work in economics, in which empirical work and firm strategies have received less attention. The investigated discourse suggested that the modelling tradition in economics is at its strongest when considering homogenous groups, static states, or other models.

More recent work on the subject has been following the theoretical emphasis set by the core articles (Majumdar & Venkataraman, 1998; Schilling, 2002). The recent articles discuss extensively the pricing decisions in networked markets, a topic which received less attention in the mainstream discussion. There are efforts to take different participants into account, but the field is rather undeveloped. Marketing researchers have made the most empirical work on diffusion, evaluating different adopter categories without reference to network externalities, with the exception of e.g. Gupta et al. (1999). Their elaborate simulation model is complex and they suggest further additions e.g. by adding strategic behaviour by complementor firms.

The following nomological map offers a summary of the relevant concepts and their relationship to firm strategies in a competition for dominance in a network setting. Figure 4 is the original nomological map of concepts and relations based on the previous part of the literature review, which serves as a theoretical case (Yin, 2003). The arrows indicate the direction of influence. Several researchers have modelled the feedback loop in their papers, often giving it a visual form. The map follows the advice by Dickson et al. (2001), which underlines the graphical presentation of feedback loops. The article claims that visualisation is important as a tool to shift the focus from states of nature to rates of change of states, or flows.

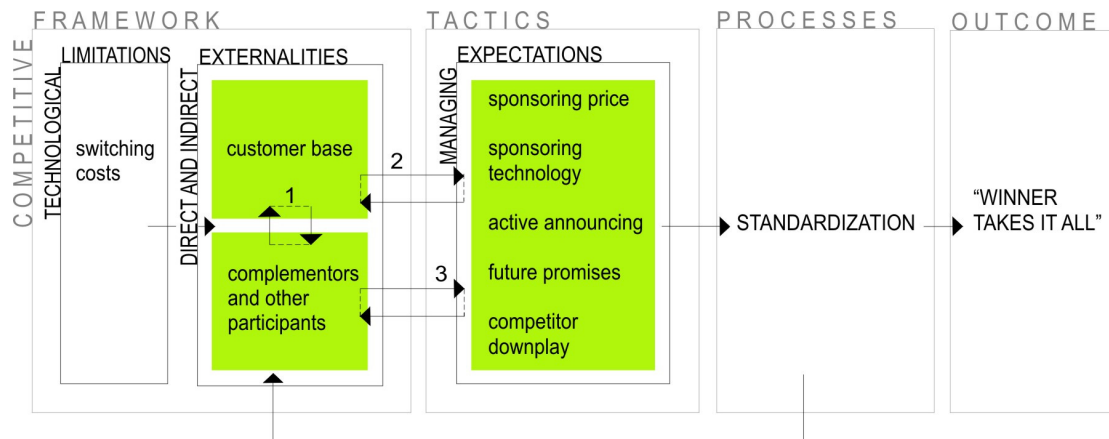


Figure 4 Nomological map on theoretical case based on the literature on network externalities

2.4.2 Competitive framework

2.4.2.1 Direct and indirect network externalities

The box in the left deals with the competitive framework, namely the origins and limitations of networks. This chapter attempts to clarify the concepts and applicability of different types of networks, and it is largely based on reading of the cited documents primarily found in the cluster E identified earlier in the bibliometric analysis.⁹

Rohlfs (1974) described network externalities as occurring when the utility that a customer derives from a service increases as others join the system. The article classifies this as “a classical case of external economies in consumption”. Telephony services are seen as an example in which a universal service policy can be seen to be justified if the new entrants pay for their incremental costs, even if it this is short of the average costs (Rohlfs, 1974). Network externalities were first identified with physical networks (Rohlfs, 1974; Katz & Shapiro, 1986a). Network externalities can

⁹ The clustering of network externality discussion was not proved practical for providing chapter division because of the group overlaps. Cluster E including the core articles on network externalities had most to offer to the this chapter, while documents found in other groups contributed more sparsely.

also be described as consumption benefits, as they create an economy of scale on the demand side (e.g. Farrell & Saloner, 1992).

Research has widened the scope of analysis and made a distinction between direct and indirect network externalities (Farrell & Saloner, 1985; Katz & Shapiro, 1985; Katz & Shapiro, 1986a; Shurmer, 1993). Direct externality occurs when the number of users directly influences a product's utility (Katz & Shapiro, 1985; Katz & Shapiro, 1986a; Economides, 1996). Direct network externalities can be observed in communication networks, electrical distribution, and railroad industries (Rohlf's, 1974; Katz & Shapiro, 1985; Katz & Shapiro, 1986b, 1986a; Church & Gandal, 1992; Economides, 1996).

An indirect network externality is present when demand is indirectly influenced by the availability of complementary products (Katz & Shapiro, 1985; Katz & Shapiro, 1986a; Church & Gandal, 1992). Industries in which indirect network externalities have been identified include the personal computer industry, the recording industry, the credit card industry, and the television and broadcasting industries (Katz & Shapiro, 1985; Katz & Shapiro, 1986a; Church & Gandal, 1992; Katz & Shapiro, 1992, 1994; Cottrell & Koput, 1998; Gupta et al., 1999; Gandal et al., 2000; Le Nagard-Assayag & Manceau, 2001). In Shurmer's (1993) definition, the indirect network externalities are derived from features extrinsic to the product, which increase with the number of adopters, and which add value to the product for the participants (Shurmer, 1993).

Strongly complementary products may be described as forming systems, even if consumption of these products is not fixed. Some authors describe the situation as system markets (Katz & Shapiro, 1994), or a hardware-software paradigm (Church & Gandal, 1992). Even though companies would otherwise be separate, network externalities create interdependency (Church & Gandal, 1992; Antonelli, 1993; Wade, 1995; Gupta et al., 1999; Le Nagard-Assayag & Manceau, 2001). An increased number and variety of externalities improve the total offering (Matutes & Regibeau,

1988; Church & Gandal, 1992; Cusumano et al., 1992; Shurmer, 1993; Gandal, 1994; Arthur, 1996)¹⁰.

There is some terminological confusion also as to how the literature may use the same terminology linked to indirect network externalities, whilst referring principally to a wider network context (Farrell & Saloner, 1985; Gabel, 1987; Matutes & Regibeau, 1988; Church & Gandal, 1992; Farrell & Saloner, 1992; Shurmer, 1993; Besen & Farrell, 1994; Gandal, 1994; Brynjolfsson & Kemerer, 1996).

The limits of network externality markets are not clear-cut. In addition to direct and indirect externalities, Katz and Shapiro (1985) also consider a situation in which positive consumption externalities rise due to the quality and availability of post-purchase service. Even with this addition, the list of sources is not exhaustive. They add more subtle links between benefits and sources in their footnote, such as product information for more popular brands; the role of market share as a signal of product quality; and bandwagon effects (Katz & Shapiro, 1985), which differentiate from externalities phenomenon. Banking and insurance companies' offerings and its interdependence with the customer base have many similar features to the industries mentioned (Arthur, 1996).

Cusumano et al. (1992) differentiate bandwagon effects from network effects. In the article, bandwagon effect refers to situations in which early sales or licensing of a particular product lead to rising interest. Support for one standard over another can become especially dynamic and self-reinforcing if customers perceive there to be value in owning that standard. For Cusumano et al. (1992), network externalities refer to whether or not there is a usage pattern that depends on such a complementary product, as well as how and how much customers use the complement with the main product. The bandwagon relates closely to the communication necessary for realising the possibilities of an emerging network. David (1990) calls a 'bandwagon' a dynamic process, which overcomes coordination and communication problems among potential network adopters.

¹⁰ Liu et al. (2004) shows by economical modeling that multiplication of television channels does not necessarily increase consumer welfare, depending on the broadcasters' cost of quality provision .

Arthur (1996) describes network effects as a reason for increasing returns. Increasing returns describe networked, or interdependent markets with positive feedback loops, which magnify the importance of a small events in the early stages of diffusion, or in the path of history (Arthur, 1989, 1994, 1996).

The confusing use of terms has not been remedied by the recent research. Some of the more contemporary documents (the evaluated 12 journal articles) do not necessarily mention indirect network externalities explicitly but substitute the term with network externalities (Schilling, 1998; Bhargava *et al.*, 2000; Van Hove, 2000; Kauffman & Walden, 2001; Schilling, 2002). The more traditional form of 'direct network externalities' is also often equated with 'network externalities', (e.g. Schilling, 1998; e.g. Hellofs & Jacobson, 1999; Kauffman & Walden, 2001; Schilling, 2002). Majumdar and Venkatamaran (1998) made a distinction between the different types of effects that networks have. Schilling (1998) equated the term 'network externalities,' including both direct and indirect network externalities, with 'positive consumption effects'. Van Hove (2000) uses the term consumption effect to underscore communication patterns affecting perceptions, while preserving the value of large network of a product (Van Hove, 2000).

Following the core documents in the network externality discussion, I recognise that network externalities are present when growth of a network improves the product offering. This network feature differentiates the concept from ideas based on communication about the network. Network features and communication about the network might be observed simultaneously.

Indirect and direct mechanisms are created from different network structures and product offerings. With indirect externalities, a core product or service offers a link between customers and different complementary products, rather than links among customers. Externalities are derived from features extrinsic to the core product or service. A rising number of adopters or complementary products adds value to the offering. Therefore, industries facing significant indirect externalities have strong reliance on complementary products e.g. customers value highly features that are not offered by the core provider, but by complementary ones. The distinction between core and complementary products can be unclear, because some firms bundle more features in the core product while leaving a smaller role for complementary products.

In addition, the most important network externality articles are not able to identify, when an industry is facing significant indirect network externalities. For this reason, the industry listings seem quite subjective. This problem is not easily solved, because indirect externalities can be quite diverse. The effects vary by product attributes, with externality-sensitive attributes gaining more from the increased availability of complementary products (Basu *et al.*, 2003).

Both direct and indirect externalities affect adoption patterns, because of the increased interdependence of decision-makers. Interdependence initially increases after some time-lag in early adoptions, but the same mechanism encourages adoptions after new complementary products arrive in the market to improve the total market offering (Gupta *et al.*, 1999). Above a certain point, ‘critical mass’, the adoption of new products is strongly enhanced by the interdependence in demand derived from different parts of the offer (Antonelli, 1993)¹¹.

The different implications of direct and indirect externalities can be found, for example, from Gupta *et al.*’s (1999) study on the evolution of television markets. The aim was to forecast the sales of high definition television in the U.S. market. The article models both direct and indirect dependence and considers also consumer heterogeneity. The interactive model including consumers, as well as core and complementary products produced several results. A major contribution is to show how indirect network externalities produce different adoption curves than in markets without that effect. The authors claim that forecasts that ignore indirect effects lead to results biasing towards HDTV. Authors also argue that contrary to the beliefs of television manufacturers, sponsoring equipment was not efficient to spur sales, because a major segment of the audience (‘Videophiles’) is price insensitive. Instead, a lack of HDTV programming would seriously hamper sales. Gupta *et al.* (1999) acknowledge that their model is complex and demands much information. They argue that an explicit treatment of indirect network externalities should be carried further. They give an example of possible avenues for this by modelling strategic behaviour with respect to other firms. This would include the inter-firm interactions of complementor firms, by incorporating competitive reaction variables.

¹¹ The analogy of “critical mass”, borrowed from physics, is rather problematic in societal diffusion e.g. there cannot be a pre-determined certain point when evaluating human behaviour.

2.4.2.2 Switching costs

The 'direct and indirect network externalities' of the map are affected by the technology used. The potential cannot be reached because of e.g. technological limitations, or differences between available technologies, or networks. Network competition is affected by switching costs, which are incurred when a firm, or a customer has to change from one supplier or technology. Switching costs may weaken competition and raise prices, as it segments the market. This grants some monopoly power to the original provider, which companies may leverage by increasing prices (Klemperer, 1987; Farrell & Shapiro, 1988; Beggs & Klemperer, 1992). It is also a first-mover advantage (Lieberman & Montgomery, 1988). Switching costs can be divided into transaction costs, learning costs and artificial or contractual costs. An example of the first category is a fee for switching an account or customership. Learning costs are incurred when a customer has to learn how to use a new product. Artificial or contractual costs arise at the firm's discretion e.g. brand loyalty 'frequent-flier' programs (Klemperer, 1987; Lieberman & Montgomery, 1988). Arthur (1996) terms switching costs as related items such as up-front costs and customer groove in. The latter describes a situation where the more consumers use e.g. a particular piece of software, the more they become attached to the software and its upgrades.

Switching costs borne by buyers may lead to technological lock-in for sellers (Porter, 1980; Farrell & Shapiro, 1988). This may be particularly so if the complementary products form tightly connected systems (Katz & Shapiro, 1994; Arthur, 1996). The systemic nature of product production and offering distances the market from the perfect market ideal (Katz & Shapiro, 1994; Arthur, 1996).

There is anecdotal evidence of how the greater market power of a dominant firm could also lead to the exclusion of new entrants (Porter, 1980; Farrell & Shapiro, 1988). In a related article, Kerin et al. (1992) propose that higher switching costs or costs of mistakes give differentiation advantages to the first-mover. They also argue that the advantages related to switching costs are more important in consumer markets than in industrial markets, because the industrial market is more competitive (Kerin et al., 1992).

Switching costs are higher when there is no compatibility between systems. In the early stages of industry evolution, competitors compete intensely to build their installed bases if they have incompatible products (Katz & Shapiro, 1986a; Klemperer, 1987; Besen & Farrell, 1994). The possibility to have a proprietary, profitable, and sustainable installed base is a strong incentive to compete and even to sell under costs in the beginning of the adoption process. Resource-draining competition eases if the firms decide to make and market compatible products in normal competitive terms. The first-mover advantages, and therefore the incentives to compete fiercely, are diminished if the products are compatible in a new industry (Katz & Shapiro, 1986a; Economides, 1989; Besen & Farrell, 1994). The situation may change as the industry matures (Katz & Shapiro, 1986a). Compatibility improves variety, and secures second sourcing (Matutes & Regibeau, 1988; Katz & Shapiro, 1994).

2.4.3 Competitive tactics and expectations management

This chapter (see second box from the left in Figure 4) evaluates research dealing with what firms do; their tactics, or ‘manoeuvres’ to win the competition for technology dominance (Suarez, 2004). A major issue in the network externality context is the installed base of customers and suppliers, which provides the incentive for many of the actions. Creating credible and favourable beliefs about the installed base is a major strategic consideration for managers (Padmanabhan et al., 1997). Firms try to use the installed base effectively, because it affects further adoption and it is a potential entry barrier for competitors (Katz & Shapiro, 1985; Farrell & Saloner, 1986a).

Besen and Farrell (1994) contrast network externalities with the somewhat similar situation of economies of scale, or learning by doing. With the latter two examples, current or cumulative sales are the basis of decisions and action. However, network externalities are interested in the increasing value of expanding networks. Therefore, the current state is not as crucial in network markets as is the expectation of the ultimate state of the network (Besen & Farrell, 1994), see also (Cusumano et al., 1992; Shurmer, 1993; Katz & Shapiro, 1994; Padmanabhan et al., 1997).

Network externalities as a network feature and signalling about the network benefits are closely tied. The emphasis on managing expectations about the network may lead to firm policies on giving an audience exaggerated, or even wrong information about the base.

Announcements on product launches and upgrades are used to lure customers to wait for a firm's product, discouraging them from using competitor's products, or old technology (Porter, 1980; Farrell & Saloner, 1986a; Besen & Farrell, 1994; Arthur, 1996). Some evidence shows that adopters use diverse information channels for purchasing decisions, which implies that it is difficult to give individual false statements in an effective, or a long-lasting manner (Shurmer, 1993). Announcements, even when not truthful, may have a significant impact. A provider of existing technology, or an industry leader, could develop an installed base with major momentum, unless the challengers can provide reliable information about a significant improvement at hand (Farrell & Saloner, 1986a; Besen & Farrell, 1994; Arthur, 1996). The preannouncement can also cannibalise the firm's own portfolio, as customers delay their purchases whilst waiting for new versions (Besen & Farrell, 1994). In a related compilation, Rosenberg (1982) deduced how expectations may lead to longer adoption times for discontinuous innovations. The introduction of a new substitute technology often evidences improvements in the former technology, so it is rational for potential adopter to wait for events to unfold (Rosenberg, 1982).

Signalling about the good reputation of the seller may convince others to join the network more readily (Katz & Shapiro, 1994). Perceived product quality is a device to manage expectations. Rosenberg (1982) argued that in their initial technology selection, potential adopters prefer a provider that will upgrade its products if there is a chance that the technologies used will become obsolete (Rosenberg, 1982). Padmanabhan (1997) modelled a situation in which a firm offers its single product sequentially to different customer groups. By introducing a lower quality product for the network externality market, a firm can capture the network externality benefits by selling improved upgrades. It was shown that it was more profitable to delay full quality products and serve first the higher value customers, than to serve everyone well at once. This reasoning is based on assumption that customers do not have full knowledge of the value of network effects. The authors acknowledge that in reality

the race for an installed base may be more important in shaping product entry policies (Padmanabhan et al., 1997). Other long lasting commitments such as a wide product offering and other sunk costs by the seller also act as a hostage in the eyes of the potential entrants (Besen & Farrell, 1994; Katz & Shapiro, 1994).

Firms weigh the costs and rewards of pre-announcing, keeping in mind both consumer (demand stimulation) and competitive behaviour (pre-emption), suggests a related article by Eliashberg and Robertson (1988). The article derives part of its hypothesis from the works of Farrell and Saloner (1986). The authors claim that in their data, preannouncement was most readily seen with products having switching costs. The other important motives for pre-announcing were a challenger position, a small size of the firm, or an attractive, but non-combative competitive environment (Eliashberg & Robertson, 1988).

Announcements on product variety signal the benefits of indirect network externalities. The value of a product improves, when there are more complementary and compatible products available (Matutes & Regibeau, 1988; Church & Gandal, 1992; Cusumano et al., 1992; Shurmer, 1993; Gandal, 1994; Arthur, 1996). Variety widens the access of the network, which actually leads to an improved product (Katz & Shapiro, 1994).

Church and Gandal's (1992) model shows how an increasing number of software products improve the value of a technology. This leads to a larger network and increased sales of hardware, enhanced market demand for software, and improved software profitability (Church & Gandal, 1992). Katz and Shapiro (1985) analysed indirect effects on the purchasing decision of computer hardware. For example, an agent purchasing a personal computer will be concerned with the number of agents purchasing similar hardware because the amount and variety of software that will be supplied for use with a given computer will be an increasing function of the number of hardware units that have been sold (Katz & Shapiro, 1985). A consumer's adoption decision has an impact on the future variety or prices of components, and vice versa (Farrell & Gallini, 1988; Shurmer, 1993; Katz & Shapiro, 1994).

For a dominant firm, the benefit of inviting new suppliers, even competitors, is most profitable, when there are significant set-up costs involved in buying a new product.

Customers feel more committed to the offering, when there are more suppliers providing e.g. second-sourcing, open source architecture, variety and quality, which then translates to more rapid diffusion (Farrell & Gallini, 1988; Besen & Farrell, 1994; Katz & Shapiro, 1994).

Sponsoring the enlargement of the installed base may take also other means, by, for example, inviting a large buyer to the network. A committed large buyer, such as a government agency, may take the lead and sponsor further enlargement (Katz & Shapiro, 1994). Garud and Kumaraswamy (1993) describes how Sun Microsystems has sponsored an open standards system. The article illustrates that it has been an efficient way to build customer base, while it has implications for the product cycle. Because customers and rivals can free ride on a firm's research and development work, the sponsor must continually substitute its own products with improvements that customers appreciate i.e. cannibalising previous products. The improvements must be introduced rapidly, while economising R&D efforts, in order to outpace competitors and stay profitable (Garud & Kumaraswamy, 1993). In case of sponsoring firms, the supplier of the superior technology of tomorrow will be likely to dominate the market (Katz & Shapiro, 1986b). The proposition does not hold if the market has a significant bias against old technology, or insufficient friction (Katz & Shapiro, 1992). The installed base is less important in an era of technological change (Tushman & Anderson, 1986; Anderson & Tushman, 1990). The incumbent network has less value if the challenger's offer is self-evidently better (Katz & Shapiro, 1992; Arthur, 1996; Brynjolfsson & Kemerer, 1996). If the new technology is built upon the former competences, i.e. it is competence-enhancing technology, the incumbent market leader will often pioneer the adoption. In the case of competence-destroying technology, the newcomers benefit from their new way of thinking (Tushman & Anderson, 1986; Anderson & Tushman, 1990).

Predatory or penetration pricing also exploits the installed base effect, as it can prevent future entries (Farrell & Saloner, 1986a; Katz & Shapiro, 1986a, 1994). From a supplier firm's point of view, sponsoring its technology may seem to be an efficient way of building up a self-sufficient installed base (Rohlf's, 1974; Katz & Shapiro, 1986b; Besen & Farrell, 1994; Katz & Shapiro, 1994; Arthur, 1996; Brynjolfsson & Kemerer, 1996).

With moderate network externalities, new sellers with no installed base are inclined to more aggressive pricing, leading to the expansion of their market share and the decline of the earlier market leader (Farrell & Shapiro, 1988). As new entrants emerge, the dominant position of the industry leader deteriorates (Beggs & Klemperer, 1992). There is no such need for sponsoring if there has been strong demand since the beginning, and if there are less network externalities involved (Teece, 1986).

2.4.4 Processes of standardization and diffusion

Many of the core networks externality discussants treat the adoption rather mechanistically. Therefore, some articles more in the periphery of the discussion have contributed to this chapter looking at the processes of standardization and diffusion. Because the process highlights the interactions of actors, it overlaps with the previous chapter.

As noted earlier, the mechanisms working in a network externality context create a need to manage, or even to manipulate the expectations of participants by product announcements, and other public statements providing favourable information on the future firm and its products, often in comparison to the others at the early stages of market evolution (Katz & Shapiro, 1986b; Besen & Farrell, 1994; Lieberman & Montgomery, 1998; Shapiro & Varian, 1999a; Lee & O'Connor, 2003; Suarez, 2004), see also Figure 4.

Expectation management dealt with firms competing against each other, and product diffusion. The topics are overlapping but e.g. diffusion deals with issues where there is no rivalry among similar products or companies. But, both firm competition and diffusion are present when firms strive to get their offering in a dominant position. It is widely seen that a customer benefits from buying a de facto standard product or technology (Farrell & Saloner, 1985; Gabel, 1987; Anderson & Tushman, 1990; Shurmer, 1993; Besen & Farrell, 1994). The benefits are diverse and dispersed among different participants. Brynjolfsson and Kemerer (1996) review the contribution of the network externality literature on standards. The positive aspects connected to network externalities and communities of users are the following: the possibility to share information, a larger market for complementary goods and reduced market power of

sellers, increased price competition, and a greater second-hand market. Offsetting aspects of standardisation are reduced product variety or diversity, excess inertia, and efficiency loss if a 'wrong' standard is imposed (Brynjolfsson & Kemerer, 1996). There is a trade-off between standardisation and variety, assuming a firm is selling only a single good (Farrell & Saloner, 1986b). The standardisation process is similar whether the benefits arise from network externalities of the product network, or in learning-by-doing externalities (David, 1990). Econometric models and empirical data show that multiple technologies may co-exist, assuming consumer heterogeneity and product differentiation (Shurmer, 1993; Katz & Shapiro, 1994). Nelson (1998) and Suarez (2004) review research on path-dependencies (David, 1985; Arthur, 1989) and network externalities, or standards in particular (Katz & Shapiro, 1985), as different ways to explain the existence of a dominant design. The difference between path-dependencies and network externalities is that research into the latter stresses the systemic aspects (Nelson, 1998).

Arthur (1989; 1994; 1996) included the competitive context for explaining potential inefficiencies in the standardisation process. The process magnifies the effect of small, even random events early in the history of standardisation. If someone gets ahead by chance or cleverness, the magnified advantage may result in lock-in in the market (Arthur, 1996). The path-dependent process may lead to locked-in technology, which may not be the optimal one. The situation occurs only with technologies or systems that offer increasing returns. (Arthur, 1989).

Rogers (editions in, 1962, 1971, 1983, 1995, 2003) analyses the diffusion of innovations. Diffusion is described as being a social process, in which an innovation is communicated through certain channels over time, among the members of social system (Rogers, 1995). Bass (1969) mathematically re-formulated the same ideas. He modelled new product diffusion, especially concerning the timing of the initial purchase of a product. In the model, innovators make their decisions on adoption independently, whilst imitators follow them. The formulation is the following: An initial purchase is a linear function of the number of previous buyers. The model implies exponential growth of purchases until close to a peak and then exponential decay. Calculating the model, the ultimate number of purchases is used. In forecasting, this requires a subjective judgment by the researcher. In the model,

buyers do not make expectations on the future size of the network, only on the current number of purchases (Bass, 1969). Valuing a network involves not only network size, but also other features of the network. The relative importance of features may differ between different adopter groups (Shurmer, 1993). In a related article, Granovetter (1978) emphasises the variations of preferences within an interacting group, which may lead to inconsistent and hard to predict collective behaviour. A threshold is a point at which the perceived benefits to a potential actor exceed the costs. Social structures make the threshold models more complex; e.g. an action of a friend is more significant to an individual than an action of an alien (Granovetter, 1978). Rogers also acknowledged the reciprocal influence of the later adopter on the earlier adopters in interactive innovations. The S-shaped adoption curve ascends later but the incline becomes more radical than with other innovations (Rogers, 1995). This reciprocal addition emphasises the significance of critical mass, which is a system level illustration of a social threshold at which the diffusion of an interactive innovation is self-sustaining. Below that point, the number of adopters of an interactive innovation is so small that the innovation gives significantly less value to the potential adopters (Rogers, 1995).

The diffusion may not reach the critical mass. Van Hove (2000) describes the failure of a smart card trial and explains the problems using network externalities, and negative dynamics prior to reaching critical mass. The case illustrates the close relation of network externalities as an asset and expectations about them. The initial problems were magnified because of the self-enforcing loops. Word-of-mouth and mass media provided the necessary channels to communicate negative perceptions. Merchants and consumers iteratively downgraded their expectations of the future state of the network, and the trial proved unsuccessful (Van Hove, 2000).

Different network theories on adoption can be classified on the basis of their view of what the benefits of networks actually are. In their review, Abrahamson and Rosenkopf (1997) include network externalities as part of an increasing returns mechanism, in which growing networks give objective benefits. They propose that the network theories reviewed share the view that the potential adopter feels bandwagon pressures to adopt, but that the mechanisms differ. The second group, 'learning theories of bandwagons' is based on the idea that potential adopters learn about an

innovation's profitability from the existing adopters. Growing networks offer a larger base for such information. 'Fad theories of bandwagons' focus on who has adopted, as this generates social bandwagon pressure to conform (Abrahamson & Rosenkopf, 1997).

Robertson (1993) investigates the problem of diffusion from the point of view of an individual firm. The article points out that time-to-market is a critical, but largely neglected aspect of competitive advantage. Rapid market penetration is seen as being most important where product life cycles are short. The objective is reached with five policies which are: to be first in the market; to preannounce before market availability; to innovate constantly; to occupy a market with multiple brands, positioning, segments, and by building alliances; and to manage the customer purchase decision process (Robertson, 1993).

The first-mover firm has an advantage to establish its offering as an industry standard (Teece, 1986; Lieberman & Montgomery, 1988; Arthur, 1989, 1994, 1996). Lieberman and Montgomery (1988) define first-mover advantages as the ability of pioneering firms to earn positive profits in excess of cost of capital. Mechanisms leading to first mover advantages are thought to be technological leadership, pre-emption of scarce assets and buyer switching costs (Lieberman & Montgomery, 1988). Lieberman and Montgomery (1998) identify two main sources of benefits from choosing a first-mover strategy. Firstly, an early entrant can block the competitors' way through the pre-emption of valuable resources, such as prime physical locations or patents. Secondly, the first-mover strategy may give a firm an opportunity to alter the cost structure of customers. Network externalities represent alterations where customer preferences are shaped to favour a pioneer's product (Lieberman & Montgomery, 1998). If the first-mover can hold its position, delaying the entry of a first generation technology provider will increase its profits and in an extreme case could deter competitors' subsequent entries altogether (Katz & Shapiro, 1992).

In an article reviewing and synthesising research on the first-mover advantages of a firm Kerin et al. (1992) summarise theoretical-analytical explanations for this. These include explanations arguing that first-mover advantages are due to entry barriers; the first-mover finds least resistance among the most potential customers; learning by

customers gives an upper hand to the first-mover; and the first mover will have differentiation advantages (Kerin et al., 1992).

Theoretical explanations quite often overlook the uncertainties involved and the possible distinctiveness of later entrants (Kerin et al., 1992). In addition, industry pioneers have more expensive costs of regulatory approvals, educating customers and suppliers of factor inputs, and so forth (Porter, 1980). The adoption process may have difficulties at the start, especially if there are even more improvements to come (Rosenberg, 1982). Innovations seen as experimental are not appreciated by the majority of users (Anderson & Tushman, 1990). In non-cooperative standard setting, a firm is more willing to comply with a new standard if someone else has pioneered the switch (Farrell & Saloner, 1985). Teece (1986) investigates how the position of a first-mover is also more at risk if the innovation is easily imitated and the firm does not hold in conjunction other valuable complementary capabilities or assets. Commercial success may even pass from the provider of a monopoly technology to the owner of valued co-specialised asset e.g. a distribution channel. In order to profit from first entry strategies, the firm has to hold proprietary technologies or valuable complementary assets (Teece, 1986).

Lieberman and Montgomery (1988) partition first-mover disadvantages in four main areas. Firstly, later entrants may be able to 'free-ride' on a pioneering firm's investments. Secondly, late movers can delay their entry until technological and market uncertainties are resolved. Second-mover advantage may surface if the competing firms are sponsoring their technologies. Customers avoid locking in to older, possibly inferior technology (Katz & Shapiro, 1986b). Thirdly, new entrants may see and exploit new technological discontinuities that were not earlier available. Fourthly, a pioneering firm may be locked-in to outdated assets, or be reluctant to make radical changes with existing product lines, or may have become otherwise organisationally inflexible (Lieberman & Montgomery, 1988). Rapid growth shifts the emphasis to the future, placing a competitive pressure on firms. Cusumano et al. (1992) describes how competitive mass consumer product markets often experience a slow standardisation, which favours the follower firms who can avoid the pitfalls of their predecessors (Cusumano et al., 1992). Kerin et al. (1992) propose that in the case of the rapid evolution of markets, the first mover's cost and differentiation advantages

shrink (Kerin et al., 1992). If technologies become obsolete, the installed base loses its significance. It follows that lock-in effects do not play a part, and that prices fall. Current profits and expected total discounted profits may be lower in rapid growth industries (Beggs & Klemperer, 1992). The 'late-mover advantage' stream focuses on the difficulties of holding onto leadership, especially on the technological front. The notion of strength in building strong complementary assets (Teece, 1986) could be judged as a first-mover strategy in firm relationships and networks. Provision of large variety by a later entrant can also be a strategic manoeuvre to defeat a first-mover firm that is stronger in innovation (Lieberman & Montgomery, 1988; Cusumano et al., 1992). In the rivalry for the dominance of the VCR-standard, groups of firms organised themselves to produce and distribute a product in sufficient numbers, which usurped advantage of the former industry leader. Later, the producers of complementary products aligned strategically, which reinforced the acquired advantage. The complementary producers' action possibly cut the predecessor's, or the first-mover's chances of survival even as a second format. Both periods were marked by the importance of complementary parts of the network and the efficient management of the network (Teece, 1986; Lieberman & Montgomery, 1988; Cusumano et al., 1992; Besen & Farrell, 1994).

2.4.5 Competitive outcomes

Positive feedback loops in network markets lead to a tendency towards standardisation (Arthur, 1989; David & Greenstein, 1990; Cusumano et al., 1992; Shurmer, 1993; Arthur, 1994; Besen & Farrell, 1994; Katz & Shapiro, 1994; Arthur, 1996), see Figure 4. In a network market, or with complex products, firms and technologies enjoy first-mover advantage because a rapidly established base of customers and complementary products provides increasing returns (David, 1985; Klemperer, 1987; Arthur, 1989, 1994; Tegarden *et al.*, 1999). The imitation of an industry leader by follower companies is one way of managing risk with uncertain technological solutions (Porter, 1980). When the adopters start to switch systems, the change may take only a short time once one provider has gained initial edge. Potential adopters are prone to tipping, as they do not want to be stuck with an inferior network (Besen & Farrell, 1994; Katz & Shapiro, 1994). Network markets are described as 'tippy' - referring to the network participant behaviour close to the ex post critical

mass point. The unstable co-existence of incompatible products may lead to the sudden defeat of competitors after one standard or company has had an initial advantage (Besen & Farrell, 1994). Excessive inertia may take place, supporting the dominant players, even in cases where improved products were soon available (Arthur, 1996). Often, the described process ends up where 'winner-takes-it-all' (Katz & Shapiro, 1986b; Besen & Farrell, 1994; e.g. Arthur, 1996; Lieberman & Montgomery, 1998; Shapiro & Varian, 1999a).

David (1985) demonstrated the story of the diffusion of the QWERTY keyboard typewriter as an example of the success of inferior technology¹². The major reason for premature resolution was a decentralised, path-dependent adaptation process, where chance elements can dominate. Technical interrelatedness created system scale economies. As QWERTY gained a slender lead, more typists were ready to switch to the system and the firms' costs of acquiring the system decreased. Learning efforts put into typing skills were also quasi-irreversible investments strengthening path-dependence. A growing network was also a signal for manufacturers. Non-QWERTY manufacturers saw growth opportunities in serving a wider clientele, and changed their product offering accordingly (David, 1985).

The firms have to possess the capacity to initiate technological changes, or to respond rapidly (Anderson & Tushman, 1990). In knowledge-intensive industries, evolving markets are more unstable and hard to predict, placing more strain on managers who have to adapt to rapidly changing situations (Arthur, 1996). Firms may have difficulties in keeping pace with the industry, which has implications for performance. The first-mover firm has to have both the willingness and resources to manage its early lead or it will lose its advantage (Lieberman & Montgomery, 1988; Arthur, 1996). Arthur (1996) argues that weak firms have only two alternatives; "slow death, and graceful exit". The former leading firms may still remain in the industry for a long time, but playing only a side role (Arthur, 1996).

The case of the videocassette recording system has been quoted as another example of a technologically inferior winner, but this time with a second mover who triumphed.

¹² There is criticism outside of the core documents, which argue that the story of QWERTY is misrepresented (Liebowitz & Margolis, 1990" *Journal of Law and Economics*, April 1990, 33:1, 1-26)

Cusumano et al. (1992) describe how the VHS-system overtook the position of Beta, formerly the leading format for home VCR-equipment. The case differs from insights given by David (1985) and Arthur (1989) in stressing that the competitive situations and the eventual outcome reflects the deliberate, and timely actions of the major participating firms (Cusumano et al., 1992).

2.4.6 Summary of the network externality review

This chapter pulls together the previous insights, and provides help for interpreting Figure 4.

A networked market is often seen as resulting in a situation in which the industry leader will dominate the market (e.g. Katz & Shapiro, 1986b; Lieberman & Montgomery, 1988; Besen & Farrell, 1994; Arthur, 1996). Initial successes, or failures draw the different paths of firms even further apart, because of path-dependence (Noda & Collis, 2001). Positive feedback or increasing returns tend to magnify even small events which occur during the change in the development of an industry (David, 1985; Arthur, 1989, 1990). Path-dependence, network interdependency, and high adoption rates after critical mass create firms with strong incentives to dominate the market and to use first-mover strategies, which often leads to a 'winner-takes-it-all' situation (Katz & Shapiro, 1986b; Besen & Farrell, 1994; e.g. Arthur, 1996; Lieberman & Montgomery, 1998; Shapiro & Varian, 1999a).

There are three kinds of closed feedback loops in the nomological map. The first loop is the installed base of customers and a network of complementary products and services, each side of the equation acts on the observed and anticipated changes of the other (Katz & Shapiro, 1985; Katz & Shapiro, 1986a; Church & Gandal, 1992; Shurmer, 1993; Schilling, 1998; Gupta et al., 1999).

The second loop is between the installed base and the role of expectations and management, which has variety of implications. An installed base of customers gives information to potential adopters about the viability of the offering. Firms try to manage how others perceive the network growth, because new customers are attracted to join a viable and growing network of existing customers (David, 1985; Farrell & Saloner, 1985; Katz & Shapiro, 1985; Farrell & Saloner, 1986a). Later-adopters look

for information to back their adoption decisions. The role of expectations implies several tactics that are available to managers to influence their customer base. These include active announcements about the installed base, a complementor network, and other signs of the viability of the offering (Cusumano et al., 1992; Shurmer, 1993; Besen & Farrell, 1994; Katz & Shapiro, 1994; Padmanabhan et al., 1997). Announcements are future orientated in order to convince current and potential customers, and are of major importance to managers. As the networked market tends to favour early-mover strategies, a firm may be willing to restrain the success of its major competitors. Therefore, predatory and aggressive information towards competitors may be included (Porter, 1980; Farrell & Saloner, 1986a; Katz & Shapiro, 1986b; Eliashberg & Robertson, 1988; Besen & Farrell, 1994; Arthur, 1996; Padmanabhan et al., 1997). However the situation is different, if a competitor is a member of the same network. Building a viable market is an opportunity for all the participants (Katz & Shapiro, 1985). The distinction between a hostile or co-operative attitude lies in the evaluation of competitors related to their complementary role in the firm's own network and to the growth phase of the market (Church & Gandal, 1992).

Building a good complementor network offers more variety, and is therefore an improved offering for customers (Katz & Shapiro, 1994). The third loop consists of the complementary network and the role of expectations. All of the network participants, whether they are firms or customers, evaluate the current and future quality of the network. As with the installed base, a viable network attracts more actors to join the network. Efficient management of a complementor network can offer strong later-movers a chance to overcome the incumbent (Teece, 1986; Lieberman & Montgomery, 1988; Cusumano et al., 1992; Besen & Farrell, 1994). Pricing and other sponsorship is a way to invite new members to join the network, whilst preventing the competitor's marketing efforts. Sponsoring can be targeted to other firms as well as to customers. Sponsoring lowers switching costs, so it is a way to capture new customers, whether they are potential adopters of technology or existing customers of competitors (Rohlf's, 1974; Farrell & Saloner, 1986a; Katz & Shapiro, 1986a, 1986b; Farrell & Shapiro, 1988; Besen & Farrell, 1994; Katz & Shapiro, 1994; Arthur, 1996).

First-mover advantages are not explicit in the map, as they are a combination of different activities, or motivations for such actions. First-mover advantages include switching costs, which discourage people from switching from the product or network. This has an effect on both the current adopters and the potential adopters. The first group has a preference for staying with their original supplier, thus favouring the first mover (e.g. Porter, 1980; e.g. Farrell & Shapiro, 1988; Lieberman & Montgomery, 1988; Kerin et al., 1992). For the latter group, the higher perceived costs of selecting poorly and switching later may act as a hindrance to adopt in the first place (Farrell & Gallini, 1988; Besen & Farrell, 1994; Katz & Shapiro, 1994). Firms may be willing to participate in standardisation, compatibility and sponsoring, which lessens the switching costs (Katz & Shapiro, 1985; Gabel, 1987).

The summary above emphasises the future-orientation of network participants. It seems that although researchers emphasise path-dependence, history is left out of the modelling effort. Researchers have suggested that small events are magnified in the course of history (Arthur, 1989, 1994, 1996), but the path-dependence models do not include the effects of separate but influential overlapping paths. The network externality researchers widely support the idea that the dynamic setting leads to one actor or technology having a dominant position. However, there are opposite examples present, such as competitors of the Windows operating system with their respective software. The problems are a sign of a research gap in the understanding about what actions firms take in a network context, and how firm dynamics evolve.

The reviewed discourse does not provide an entirely concise view of firm strategies. The cited documents emphasise first mover strategies, or strong, even aggressive second mover strategies, at least for firms that are offering key technologies, or core products in an offering. There is some work covering how the other firms react when one firm is striving to dominate the market e.g. (Besen & Farrell, 1994; Katz & Shapiro, 1994; Arthur, 1996), but their chosen approach limits their applicability. The articles underline the dynamism, but the used approaches (economic modelling, or static multi-firm data) do not necessarily reveal well how events unfolded.

The scope for network externality concepts has been growing and evolving since Rohlfs (1974). A shift to more knowledge-intensive modes of production with more positive feedback loops affects industry evolution, leading to an expansion of the

applicability of network concepts (Arthur, 1996). However, the boundaries of network competition are not clearly defined. For a firm, the positive effects of the enlargement of a network should be weighed against the negative effects of increased competition (Church & Gandal, 1992). Porter (1980) argues that industry growth is critical in emerging industries but that managers have to change their focus to be more firm-centred when the industry matures (Porter, 1980). Even the proponents of networked economy acknowledge that expansion has its limits. Arthur (1996) claims that a more traditional ‘decreasing returns regime’ which usually produces repetitive outputs with low knowledge content in approximately perfect competition will survive, often in the same industry, and even in the same company (Arthur, 1996).

2.5 Approaches to industry evolution

The nomological map summarising the insights in the network externality discussion (Chapter 2.4.1) illustrated how different factors contribute to the success of a firm or technology in network externality markets. However, a fragmented and theory-orientated discourse did not offer clear guidance on the relative importance of the factors. This suggests that there is a need to find a different, unifying theory able to capture processes in competition. The dynamic approach, with heterogeneous actors, is one of the major challenges of the existing literature. There is a need to find approaches that are relevant to network externalities, whilst having the ability to capture dynamism in real-world settings. The mapping of related research streams (Chapter 2.2) and research fields used concepts that might be fruitful for investigating network externalities. The highlighted groups focused on firm resources, innovation, market structure, knowledge, learning, adaptation, and selection.

One of the insights in the network externality discussion is the emphasis on feedback. Amongst the related research fields, the different evolutionary frameworks take into account the longitudinal development with feedback mechanisms, which could be helpful in answering some of the open questions in the current discussion. In the following chapter, the evolutionary approaches included in group V of the previous bibliometric study are further examined¹³. Firstly, the positive feedback mechanism is

¹³ Other potential candidates for further review were resource-based view, the knowledge-based view, and approaches focusing on social capital and dynamic capabilities, which widely share learning related concepts.

discussed, concentrating on the evolutionary perspective on economics (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982). Research on institutions and the resource-based view are covered in this section. Secondly, the negative feedback mechanism is discussed. Here, the focus is on population ecology (Hannan & Freeman, 1977, 1984), which assigns more impact to competition and selection mechanisms. Thirdly, a summary is given that highlights the differences between the approaches.

2.5.1 Underlying theoretical perspectives

The evolutionary perspective on economics and population ecology are closely related to the work of Joseph Schumpeter, whose ideas on dynamism have been the catalyst for much of the empirical and theoretical work investigating the links between technological change, population, organisation, and individual outcomes (e.g. Nelson & Winter, 1974; Barney, 1986; Tushman & Nelson, 1990; Nelson, 2002). In reviews, Schumpeter's work has been evaluated as being a challenger to classical economic modelling. The latter focuses on short-term market equilibrium, and has largely limited the scope of economic action to optimisation procedures involving profit maximisation motivation and a diminishing returns mechanism (see critique e.g. Alchian, 1950; Nelson & Winter, 1974; Clark, 1988; Arthur, 1989, 1990; Dickson *et al.*, 2001; Clark & Rowlinson, 2004). In classical tradition, profit-maximisation was focused on a firm's close domain, while changes in technological regime or tastes in utility function are left for exogenous forces (Antonelli, 1997). In classical economic modelling, intentional action on industrial structure does not play a role (Antonelli, 1997). In a critique, March and Simon (1958) claimed that classical economic theory, with its organisational theory counterpart, failed to make explicit the subjective and relative character of rationality. There are several assumptions in the classical theories, such as that all the alternatives of a choice are given, that consequences are known, and that the rational man has a complete utility-ordering for all of the possible sets of consequences. None of these assumptions hold true in natural settings (March & Simon, 1958).

In contrast, Schumpeter and like-minded researchers have offered a view, in which technology change is treated as being endogenous; differentiating from neo-classical economists' modelling (Nelson & Winter, 1974). In evolutionary thinking, firms were

seen as optimising their actions, or potential outcome distribution, instead of seeking a unique profit-maximisation solution which logically cannot exist in an uncertain environment (Alchian, 1950). The evolutionary perspective on economics (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982), and population ecology (Hannan & Freeman, 1977; Carroll, 1984; Hannan & Freeman, 1984) theories investigate how variation, selection and retention take place. Both assume that organisations do not change easily and quickly, but that the past will affect their propensity to adapt to changes (Barnett & Carroll, 1995).

Ecological and evolutionary perspectives make inquiries about the same historical processes (Singh, 1990). The latter has also been described as a subset of the former (Meyer, 1990), while there have been times when the opposite has been suggested (Barney, 2001). There are also some differences between the perspectives. At the outset, the ecologists also viewed evolution as Darwinian, compared to Nelson and Winter's (1982) Lamarckian view of acquired heritable characteristics (McKelvey, 1994). The primary focus of research has also divided the frameworks. Population ecology has concentrated on studying processes of selection and retention, while variation has been more central to the evolutionary perspective on economics (Ginsberg & Baum, 1994). Population ecologists have claimed that they include competition, whilst others do not pay it serious attention (Freeman & Boeker, 1984). Evolutionary arguments are more interested in how the structural properties of organisms influence their adaptation to changing environmental conditions, whilst the ecological perspective gives primacy to environments that shape populations (Meyer, 1990; Singh, 1990; Meyer, 1994; Aldrich). Adaptation and selection have been seen as conflicting views in organisational science (Astley & Van de Ven, 1983; Burgelman, 1991).

Other theoretical views provide additional linkages between the ecology and evolutionary perspectives. Both underlying perspectives share a view that institutional theories can contribute significantly to organisational science. Institutional processes may play a decisive role in the primacy of ecological or evolutionary forces (Meyer, 1990). The proponents of both perspectives have explicitly claimed to include institutional theory (e.g. Meyer & Scott, 1983) in their theorising (e.g. Hannan & Freeman, 1987; Carroll & Hannan, 1989a; Nelson, 2002). Concepts of learning and

problem-solving (e.g. March & Simon, 1958) are used both in the first major studies in the evolutionary economists' framework (Nelson & Winter, 1982) and in the ecology view (Hannan & Freeman, 1977), albeit in a more supplemental manner with the latter.

2.5.2 Positive feedback mechanism and evolutionary perspective on economics

In a review, Gavetti and Levinthal (2004) suggest that the evolutionary economics framework (Nelson & Winter, 1982) provides a conceptual apparatus that is consistent with the research interests discovered in the recent firm strategy discourse (Gavetti & Levinthal, 2004). Firm strategy research has embraced a view that treats managerial choice as intentionally rational, but without the strong rationality assumptions of neo-classical economists. The evolutionary perspective incorporated incomplete information and an uncertain future in the analysis (Alchian, 1950).

2.5.2.1 Path-dependence and accumulation of knowledge

The evolutionary perspective on economics investigates how variation, selection and retention shape firms, and especially their knowledge (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982). A routine is the basic unit of analysis in studying organisational evolution in this framework. The selection process weeds out unsuccessful routines or firms, while the successful ones are carried forward. Routines are idiosyncratic, and successful copying of them from one firm to another is difficult (Nelson & Winter, 1982).

Successful retention of routines is a sign of path-dependence. Path-dependence and accumulation of knowledge are found in an organisation, a technology, and at industry level (Nelson & Winter, 1982; David, 1985). A search for new suitable ways of doing things is most likely to come from within the firm, or very close to the firm. Technological advancement tends to be cumulative, and improvements proceed along particular lines, reflecting the available understanding of technology and market demands (Nelson *et al.*, 1976; Nelson & Winter, 1982; Nelson, 1998). Firms following a technological trajectory within a certain technological paradigm find it difficult to change the developmental path (Dosi, 1982, 1988). A trajectory is the pattern of the problem solving activity following the paradigm (Dosi, 1982). Wijnberg (1995) posits that technology trajectories and paradigms should include also the users'

and customers' point of view; "[a] technological trajectory represents technological change in time as seen through the eyes of the only competent observers and judges of the process of competition: consumers (Wijnberg, 1995)". Stuart and Podolny (1996) propose that firm's role in networks constrains the direction of learning (Stuart & Podolny, 1996). Noda and Collis (2001) argue that cognitive feedback is relevant to firm strategy functions primarily at the level of individual managers, while the other positive feedback types – economic and socio-political - is evident in the industry and in the organisation (Noda & Collis, 2001). Path-dependence is suggested to be found when positive feedback mechanisms are present, especially density-dependent legitimation, learning-by-doing, economies of scale, and network externalities (Carroll & Harrison, 1994).

According to the resource-based view, firms can be seen as bundles of idiosyncratic resources (Penrose, 1959; Barney, 1991)¹⁴. In the RBV argumentation, a sustainable competitive advantage may arise from a competitors' difficulty in copying firm's resources (Barney, 1991; Peteraf, 1993). In order to exploit its strengths and to keep ahead of competition, a firm has to constantly renew its resources (Wernerfelt, 1984). Learning processes recombine existing resources to create new knowledge that forms a basis for future growth (Penrose, 1959). The processes of recombination makes learning path-dependent in nature (Kogut & Zander, 1992). The path-dependency of learning is sometimes further reinforced by increasing returns dynamics (Prahalad & Hamel, 1990). A firm's specific asset positions constitute and create a class of feedback effects which create a firm's evolutionary path (Dickson et al., 2001).

2.5.2.2 Institutions and mutualism

Research on institutions has investigated how the established behaviour patterns, social rules and conventions, 'habits' or 'social technologies' affect economic actions (Meyer & Rowan, 1977; DiMaggio & Powell, 1983; Meyer & Scott, 1983; Powell & DiMaggio, 1991; Nelson & Sampat, 2001; Nelson, 2002; Hodgson, 2003). The

¹⁴ The resource-based view has been characterised as a derivation of evolutionary economics (Clark & Rowlinson, 2004). The close links of the RBV and evolutionary frameworks are also evidenced by the fact that the classic RBV article of Barney (1991) was originally positioned as an evolutionary study. Barney (2001) argues that only the strong position of population ecology in the 1980's diverted the resource-based view from the evolutionary streams. His article further clarifies that Nelson and Winter (1982), and more recent work on the evolutionary perspective on economics, shares the same basic building blocks as the resource-based view; the concept of firm routines being analogous to firm resources in RBV (Barney, 2001).

institutional research stream has theorised that organisational structures arise as reflections of rationalised institutional rules. Conformity to institutionalised rules often is often contrary to efficiency (Meyer & Rowan, 1977). Organisations may respond to uncertainty by conforming to others through imitation (DiMaggio & Powell, 1983).

Nelson and Sampat (2001) argue that some of the notable institutional theorists have shifted their view towards thinking that institutions are developed without a coordinated, rational effort to increase efficiency, but in a more evolutionary manner leading to, e.g., cross-country differences. Path-dependence has recently received more attention from institutional investigators, and this concept increases the focus on the expectation aspects of institutions (Nelson & Sampat, 2001).

Institutional concerns have also been rigorously investigated using different frameworks, well before the emergence of institutional theory (Aldrich, 1999; Scott, 2003). Borrowing from population ecology and network externalities, Wade (1995) analysed how market success arises not only from technological superiority but also from the support from within the organisational community that the technology attracts. Organisational support from other stakeholders is a necessary resource in the first stages of technology diffusion, in an industry characterised by the existence of network externalities. These arguments stress path-dependence and first-mover advantage (David, 1985; Arthur, 1989).

The emergence of a technological dominant design can be seen as a product of community organisation dynamics. Rosenkopf and Tushman (1994) argue that community evolution is parallel to the evolution of technology. The network of actors and their relationships have a structure similar to the technology itself in a technology cycle (Anderson & Tushman, 1990). At first, only a few linkages exist among actors, but ties emerge around competing variants, producing clusters. More powerful actors have a better ability to shape and influence the path of change (Rosenkopf & Tushman, 1994). For Tushman and Rosenkopf (1992) the community involves suppliers, manufactures and users, but also governmental agencies, standards bodies and professional societies (Tushman & Rosenkopf, 1992). The social evolution can be seen as progression of numerous interrelated acts of variation, selection, and retention over an extended period of time (VandeVen & Garud, 1994). The co-evolutionary

concept was developed on the assumption that changes may occur in all interacting organisations, permitting change to be driven by both direct interactions and feedback from the system (Baum & Singh, 1994a).

Distinct subgroups in a population, termed strategic groups, can be identified by evaluating strategic and structural organisational characteristics (McGee & Thomas, 1986; Thomas & Venkatraman, 1988). Managers in a strategic group anchor their development of strategy in their evaluation of competitors' strategies (Thomas & Venkatraman, 1988). A cognitive perspective on strategic groups involves the shared perceptions and cognitions of competitors' strategies and group structure by the managers of related companies, a cognitive structure which is a force in creating institutional isomorphism (Reger & Huff, 1993). There is empirical evidence that strategic groups act as reference points to their members when forming firm strategy (Fiegenbaum & Thomas, 1995). The organisational or technological community concept differs from strategic groups in how they see similarity between organisations. Community refers to interdependence of product design, or sponsorship, while strategic group relates to similarities in organisations' strategies (Wade, 1995).

Mutualism¹⁵ describes a situation in which organisations enhance each other's viability (Barnett & Carroll, 1987) when their life chances are positively related (Barnett & Amburgey, 1990). Barnett and Carroll (1987) analysed the relationship between early telephone companies' competitive advantage and membership in a given technological system (Barnett & Carroll, 1987; Barnett, 1990). They explained how both competition and mutualism occurred simultaneously among the organisations. Firms with similar resource requirements are expected to compete more, while more complementary functions increase the potential for mutualism (Barnett & Carroll, 1987; Barnett, 1990; Baum & Singh, 1994b). Mutualism may be the direct result of differentiated organisations referring potential customers to each other, or of organisations' linked complementary functions. Indirect, or diffuse forms of mutualism are legitimacy in the eyes of customers, and embeddedness of a particular population within the wider institutional environment (Barnett & Carroll,

¹⁵ Researchers working on ecology have contributed to our understanding about mutualism. However it is reviewed here, because of its focus on positive feedback.

1987; Barnett, 1990; Baum & Singh, 1994b). Both types were found to operate in the dispersed market of early telephone companies, where large firms could improve the telephony offering of the companies. A large organisation was seen to improve both partner and network viability (Barnett & Amburgey, 1990). The reasoning and empirical focus of, particularly, Barnett (1990) is very close to views offered by network externality theorists (e.g. Katz and Shapiro, 1985). Barnett (1990) differentiates the ecology and network externality perspectives by stating that “ecological theory identifies the importance of competition within and mutualism between environmental niches. Consequently, technological compatibility is not enough” (Barnett, 1990). Empirical results did not support the network externality hypothesis, which may be due to the simplicity of the operationalisation. The article deduced a network externality hypothesis based solely on the benefits of joining a growing network, ignoring the competitive effects (Barnett, 1990).

2.5.2.3 Technology diffusion with positive feedback

Increasing returns, which can be designated as a synonym for positive feedback mechanisms (Dickson et al., 2001), manifests itself in path-dependent evolution of a successful technology diffusion. After a synthesizing work by Suarez (2004), I review representative empirical work relying on the ideas of positive feedback mechanism in networked markets.

Suarez (2004) focused on a description of competitive phases in technology competition of network markets and the tactical implications of the segmenting. The article develops its propositions by reviewing relevant literature, in which it posits network externality literature next to ‘dominant design’ and ‘diffusion’ literature, addressing different facets of technological trajectories. Suarez (2004) highlights three major findings derived from network externality models, starting with the firms’ installed base. Second is the role of consumer expectations, which is shaped by image, pre-announcements, and information availability, whilst the third is the importance of the dynamic elements of firm strategies, such as pricing and licensing policies. Fusing insights also from studies of the sociology of science and technology, Suarez (2004) describes firm- and environment-level factors that influence the outcome of technology competition. When firms are creating the market, strategic manoeuvring is most important. This includes entry timing, pricing, licensing and relationships with

complementors, and marketing and public relations to manage expectations. The market creation is a phase that ends at the start of the 'decisive battle'. The transition point is when the market has achieved critical mass. During the 'decisive battle', the most important competitive factors are credibility/complementary assets, installed base and network effects and switching cost (Suarez, 2004).

A representative contemporary network externality discussant is Melissa Schilling, who (1998; 1999; 2002; 2003) has emphasised that firms should influence the virtuous circle of a growing size of installed base and the availability of complementary products (Schilling, 2002). Growth is managed with distribution, alliance and marketing strategies. The virtuous circle received empirical support using multi-industry survey data (Schilling, 2002). The perceptions and expectations of the installed base may be different from the actual base, which was demonstrated in the evolution of U.S. video game industry (Schilling, 2003).

Lee and O'Connor (2003) proposed a model for product launch strategy and the performance of network effects products (Lee and O'Connor, 2003). It includes penetration pricing, product bundling, mass targeting, and pre-announcing as part of a firm strategy to enhance the extrinsic value of a new product. In addition to these network-related features, there are also product-related, intrinsic value drivers, such as the order of entry and relative product advantage. The interim performance measures are the size and development of the installed base. These attract more customers and complementary products, although the loop mechanism is outside the scope of the conceptual model concentrating on firm strategies (Lee & O'Connor, 2003).

Dickson et al (2001) categorises feedback effects into two major classes. Positional advantages include investments benefiting from economies of scale, mostly in production but also in utilisation of networked products. Learning dynamics help to create positional advantages. These include contagion, learning-by-doing, learning-to-learn, routines and rules and surveillance of others (Dickson et al., 2001). The figure by Dickson et al. (2001) of generic network market feedback (Figure 5) attempts to capture the evolution of market dominance. The Dickson et al. (2001) model is not clear concerning the demand side of positive feedback. The proposed usage utility efficiency measure has left out positive direct network externalities among consumers, although they were mentioned when the propositions were built. Dickson

et al. (2001) supports these ideas with anecdotal evidence on the success of Microsoft's Windows95 operating system. Previous work on software diffusion has emphasised the role of both direct and indirect network externalities (e.g. Gandal, 1994). A contribution of Dickson et al. (2001) is its illustration of how the mechanisms are affected by exogenous inputs. The supply feedback loop is fed by demand, but also by pulses of supplier innovation. On the demand side, buyers induce innovations, giving new input to the feedback.

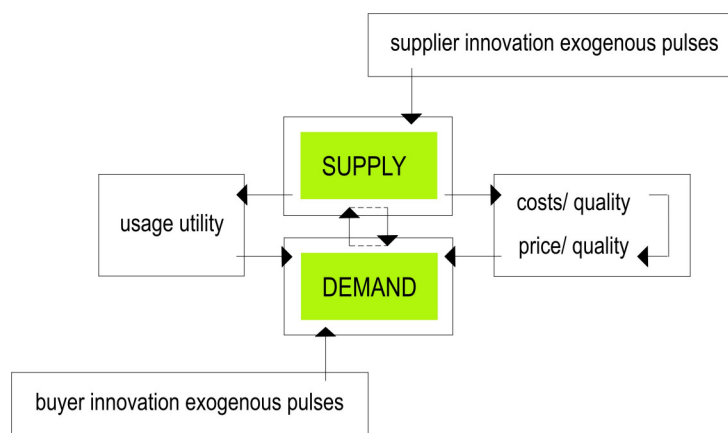


Figure 5 Adapted from Dickson, Farris and Verbeke (2001) generic model of market feedback

Gallagher and Park (2002) examined competitive dynamics in the U.S. video game industry, evaluating the succession of major game platforms by analysing documents using a historical method. Included among the findings was that 'tipping' was rare, as a number of challengers persisted with non-dominant designs (Gallagher & Park, 2002). Lowering switching costs helps challengers to enter a market (Gallagher & Park, 2002) but the success is largely dependent on the hesitation of the leader to match the action. The article suggests that switching costs are elevated e.g. with branding and supply-distributor management (Gallagher & Park, 2002). The article acknowledges the multiplicity of relevant tenets in firm management when striving to

achieve market dominance in network industries, but the proposed causalities are not as elaborate. The proposed framework is explicit on the feedback between the installed base and complementary goods, and with their relationship to switching costs. Firms are expected to learn (Gallagher & Park, 2002), which is a driving force in competition Figure 6.

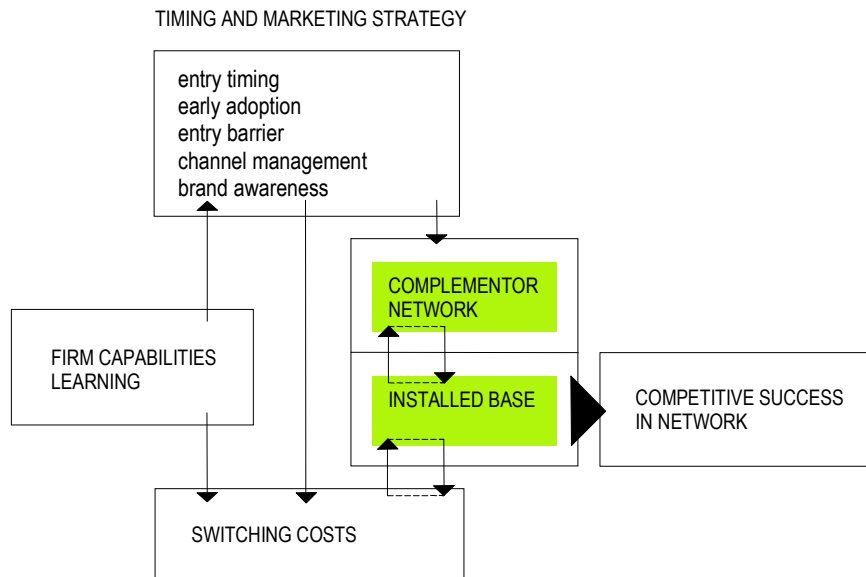


Figure 6 Adapted from Gallagher and Park (2002) conceptual framework of competitive success

Shankar and Bayus (2003) disaggregated the feedback loop in their study of the video gaming industry. The networks were featured in terms of the size of the installed base, but also the strength of the network; i.e. implying a situation in which the marginal additions had a larger impact on demand. The contribution of the article is that they find statistical support that networks can be qualitatively different. The major finding was the notion that challengers could overcome the leader if their smaller networks were stronger. In conceptual terms, the strength was the result of an interactive sense of a community among customers. The article proposes that some communities, e.g. Harley-Davidson and Apple users, are born without managerial action, but in other

cases the community is affected by marketing mix decisions (Shankar & Bayus, 2003).

Baum et al. (1995) investigated a service provided by facsimile transmission firms in Manhattan, from 1965 to 1982. They found support for the hypothesis that dominant designs and competitive processes influence founding and mortality rates in industries with significant network externalities. The rise of positive network externalities invited more entrepreneurs, which further supported the viability of the industry in a manner that earlier dominant design models could not explain (Baum et al., 1995).

2.5.3 Negative feedback mechanism and population ecology

Organisational ecology was originally concerned with how social conditions influence rates of creation, change and demise of organisational forms and organisations. Ecological perspectives, which are also outside of the sociological domain, have a common feature of focusing on selection processes (Aldrich & Pfeffer, 1976; Hannan & Freeman, 1977; Wholey & Brittain, 1986; Meyer, 1990; Singh & Lumsden, 1990; Meyer, 1994; Carroll & Hannan, 1995; Aldrich, 1999). Freeman and Boeker (1984) criticise the evolutionary perspective by Nelson and Winter for "...[failing] to conceptualise competition as a relationship between specific firms" with an erroneous understanding of stability in the markets (Freeman & Boeker, 1984 p.83). Carroll (1984) classifies three levels of analysis of organisational ecology: the organisational, the population, and the community level. Population ecology concentrates on population growth and decline and on interactions among populations (Carroll, 1984). Therefore "the population-ecology perspective seeks to understand how environmental conditions and interactions within and between populations shape the diversity of organisations in society" (Hannan & Freeman, 1987). Ecological models are interested in the distribution of fitness across a population, which has implications for the applicability of the models. The concepts are most appropriate when applied at the field, or population level instead of the single organisation, and over a relatively long time span (Aldrich & Pfeffer, 1976; Freeman & Boeker, 1984).

A basic tenet in initial population ecology theorising is that strong organisational inertia restricts organisations' ability to change, and thus they are vulnerable to changes in the operating environment. Competition and environmental constraints

lead to uniformity of organisational responses, and leaves little room for strategic management (Hannan & Freeman, 1977; Meyer, 1990, 1994). Oliver (1988) made a distinction between the institutional and ecology view of why organisations have similar characteristics in a population: “Although both explanations attribute causal supremacy to the environmental context of organisations for shaping organisational structure, the former predicts isomorphism from organisational competition, while the latter predicts isomorphism from organisational interconnectedness” (Oliver, 1988). Population ecology theories started as an attempt to underline selection processes, compared to theories based on organisational adaptation. Natural selection is seen as the dominant mechanism of social change (Hannan & Freeman, 1977; Carroll, 1984). In ecology terminology, selection is the elimination of certain types of organisations. Mortality can take the form of dissolution, absorption by merger, or radical transformation (Carroll, 1984). The environment selects out combinations of organisations, which contrast with the view of intentionally, or rationally adapting organisations (Hannan & Freeman, 1977; Carroll, 1984; Utterback & Suarez, 1993).

The initial work on population ecology focused on selection processes, leaving adaptation processes and intentional change without careful investigation (Freeman & Hannan, 1989; Mezas & Lant, 1994; Greve, 1996). A further critique is that the theoretical and empirical work was not developed in parallel (Hannan *et al.*, 2003). Population ecology started with a premise that structural inertia hindered individual adaptation, a process that was principally seen only at population level. Isomorphism was viewed to be a result of competitive pressures forcing organisations with similar constraints to behave similarly (Hannan & Freeman, 1977). Hannan and Freeman (1984) proposed that structural inertia is a consequence of a selection process, rather a precondition for it. The market is seen to favour organisations that do not make risky changes (Hannan & Freeman, 1984). Because of the stability of organisational features, ecologists have most often seen the creation of new organisational forms as a way to propel organisational changes (Hannan & Freeman, 1984; Hannan & Freeman, 1987).

Different organisational density models are used to explain regularities in the growth and decline of organisational populations (Carroll & Hannan, 1989a). According to the model, the competition and legitimising effects can explain why the number of

organisations in a population typically follows a concave pattern of growth and decline (Carroll & Hannan, 1989b). Increased legitimacy encourages more new market entries, while competition has the opposite effect (Hannan & Freeman, 1987; Carroll & Hannan, 1989b). The indirect and simultaneous measurement of 'legitimation' is criticised in e.g. Zucker (1989), Baum and Powell (1995) and Delacroix and Rao (1994).

2.5.3.1 Niches and networks

The market position relates to the concept of niche in ecological theory, borrowed originally from biology (Hannan & Freeman, 1977). A niche is defined using information on external resources (Podolny et al., 1996). The idea of a niche has been criticised, because it is very difficult to define the limits of a niche in an evolving organisational setting, compared to a situation in biology (Young, 1988). In organisational ecology, firms can define the market boundaries by their activities (Barron, 2001), and each population of firms are thought to occupy their own niche (Geroski, 2001). A niche consists of the social, economic, and political conditions that can sustain the functioning of organisations (Carroll & Hannan, 1995). Successful firms in a new niche attract new firms (Haveman, 1993), and eventually the niche will be filled, leading to the emergence of new firm strategies (Freeman & Boeker, 1984). Because the success of firms in any position is determined by competition within the position and competition from firms in positions nearby, positional markets are very complex (Hannan & Freeman, 1977; Greve, 1996).

Network-attributes are a dimension to be considered when evaluating the viability of a single organisation. An organisation's niche in a network is manifested in its points of contact with the activities of other organisations (Podolny & Stuart, 1995; Podolny *et al.*, 1996). Especially in dynamic environments, the link between past performance and present ability is often considered to be tenuous. An organisation's status is largely a function of a relational position that the organisation manages in the market (Podolny, 1995; Podolny *et al.*, 1996). A central position with many ties to other members in an uncrowded niche improves the life chances of an organisation or innovation. The positive effect of status declines with crowding. Empirical evidence from the semiconductor industry supports the hypothesis that status and crowding have an effect on the survival of firms, though the evidence on technological change

was not as clear (Podolny & Stuart, 1995; Podolny *et al.*, 1996). Podolny and Stuart (1995) consider that some evolutionary theorists may have an over simplistic view when concentrating on a local search about technological aspects. The relational context adds another dimension in which organisations have to operate. Keeping the resources for local search constant, the focus shifts from the properties of the technology itself to relational aspects (Podolny & Stuart, 1995).

2.5.3.2 Organisational change and learning

Population ecology research has shifted its understanding of change and learning, which has brought it closer to the evolutionary perspective on economics. A growing body of research examines the link between the adaptive dynamics of firms and industry (Amburgey *et al.*, 1993; Barnett & Burgelman, 1996; Barnett & Hansen, 1996; Henderson & Mitchell, 1997; Greve, 1998b; Gavetti & Levinthal, 2004).

New ecological thinking has developed novel approaches to understand inertia. Amburgey *et al.* (1993) concluded that organisational inertia can be linked with inert but also with active organisations; “[an] Organisation in motion, tends to stay in motion” (Amburgey *et al.*, 1993). Change does not necessarily have to be special *per se*, as certain forms of change can themselves become routine, while other forms of change remain unusual and, hence, risky (Delacroix & Swaminathan, 1991; Barron, 2001).

Ecological concepts have been used to investigate mimetic behaviour when analysing organisational change (Haveman, 1993; Mezas & Lant, 1994; Greve, 1996, 1998a). Gimeno *et al.*'s (2005) review found that inter-organisational mimicry can be explained by externalities among the strategic actions of organisations, competitive reactions, and non-competitive referential processes, which include information spill-over, vicarious learning, psychological, and socio-cognitive factors. Empirical evidence from the U.S. telephone industry's international expansion moves supported the competitive explanations, while vicarious learning and cognitive aspects were not as evident (Gimeno *et al.*, 2005). Mezas and Lant (1994) propose that mimetic search may guide an organisation's experimental learning process, leading to organisational change. Haveman studied diversification, and found that successful firms attract new firms until the competitive effects overrule the legitimation effect (Haveman, 1993).

In a study of Manhattan hotel industry, Baum and Haveman concluded that new ventures tend to be located close to established ones and have similar pricing, but differentiating with size (Baum & Haveman, 1997). In series of studies on the market positions of radio stations, Greve (Greve, 1995, 1996, 1998a, 1998b, 1999) suggests that managers mimic others in their reference group to search for relatively uncrowded niches (Greve, 1996, 1998a). Uncertainty can be resolved by turning to imitation rather than inaction (Greve, 1996). Actions have a greater propensity to be mimicked if they are observable, and if they have potentially strategic relevance (Greve, 1998a). A manager having too much, or unreliable information, may find it beneficial to rely on a competitor's visible choices, even without corresponding performance data. Because the decision-manager's attention is focused on competitors, their example sets the agenda and influences judgements (Greve, 1998a). In Lee and Pennings' (2002) model, the firms imitate their peers and evaluate the overall market situation. Both market feedback and amplifying firm level effects are part of the institutional process (Lee & Pennings, 2002).

In a review, Hannan et al. (2003) state that one of the rather isolated theory fragments spawned by organisational ecology and demography is 'Red Queen' evolution (Barnett & Hansen, 1996; Barnett & Sorenson, 2002). Using the term coined by Van Valen (1973) for biological evolution, Barnett and Hansen (1996) discuss 'Red Queen' competition.

'Red Queen' competition refers to competition in which a company that is immersed in competition responds to it through a localised search, learning, and capability development process. As this response marginally increases the competition faced by the responding firm's competitors, it triggers similar actions by competitors (Noda & Collis, 2001). A firm's actions trigger similar responses, and the self-reinforcing competitive cycle starts gradually driving industry dynamism and evolution. However, when observed from within the system, there do not seem to be any significant changes taking place with respect to the competitive positioning. As the business system starts evolving, subsequent competitive actions aimed at coordinating the evolution or jockeying for a position lead to immediate pre-empting of the action by alert competitors. The responses induce further responses and the self-reinforcing competitive cycle gradually starts driving industry dynamism and evolution. When

observed from the outside, the system was developing with great speed (Barnett & Hansen, 1996; Barnett & Sorenson, 2002).

The situation can be applied to network evolution. The focal companies compete in similar manner e.g. emphasising efficiency requirements. There is less incentive to stay in the market, because the profits are lost to benefit suppliers and customers. If continued, this 'Red Queen' competition leads to the deterioration of the existing firms, giving room for new ones.

The idea of 'Red Queen' competition is a further development of learning and change related research in the population ecology stream. It focuses explicitly on the dynamic nature of competition, acknowledging the intentions of managers and the boundaries of their actions. There has been work around aspects of 'Red Queen' competition (Barnett & Hansen, 1996), but its explicit applications have been scarce (e.g. Barnett & Hansen, 1996; Barnett & Sorenson, 2002; Sorensen & Sorenson, 2003).

2.5.4 Summary of the theoretical approaches

This chapter provides a summary of the previous sections on positive feedback mechanisms, especially the evolutionary perspective on economics (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982) and negative feedback focusing on the contributions from population ecology (Hannan & Freeman, 1977, 1984). Both theoretical approaches evaluate variation, selection and retention on various levels of analysis, suitable for firm strategy research (Barnett & Burgelman, 1996). Previous work on network externalities and network externality market contexts provide a modern empirical setting to investigate the issues raised in these traditions.

The research suggests that positive feedback in the forms described would be clearly evident, and the loop would have wide repercussions. In evolutionary theory, the emphasis is on successful retention of routines (Nelson & Winter, 1982). The path-dependence is observable at an organisation, at a technology, and at industry level (Nelson & Winter, 1982; David, 1985). Research built on evolutionary perspective has reasoned that there are various positive feedback mechanisms working inside the firm (e.g. routines, effective leveraging), among the firms (e.g. adaptation to a certain set of behaviour, increase in complementary firm entries) and in the firm's market

(e.g. interdependent demand, variety and diffusion as sign of product quality, diffusion of knowledge on the network offer). Cumulative technological advancements proceed along particular lines, reflecting the current understanding (Nelson *et al.*, 1976; Nelson & Winter, 1982; Nelson, 1998). The processes of recombination also makes learning path-dependent in nature (Kogut & Zander, 1992) reinforced by increasing returns dynamics (Prahalad & Hamel, 1990). Positive feedback magnifies small events, and makes the different evolutionary paths diverge (David, 1985; Arthur, 1989). The increased value of a large or varied offering is another, distinctive factor fuelling positive feedback mechanisms (e.g. Schilling, 2002; Suarez, 2004).

The ecological theory focuses on the survival of organisations, emphasising competitive pressures (Hannan & Freeman, 1977; Carroll, 1984; Hannan & Freeman, 1984; Hannan & Freeman, 1987). After the population has reached legitimacy, learning-related and market-related competition work against the success of an individual firm (Carroll & Hannan, 1989b). Ecology arguments stress exhausting exploitation, compared to an exploration. Firms adapt to changing environments with inertia (Hannan & Freeman, 1984) or by following someone who has performed the required move earlier (Amburgey *et al.*, 1993; Haveman, 1993; Mezas & Lant, 1994; Greve, 1996, 1998a).

In the ecological perspective tradition, the exploitation of existing relationships and stretching the limits of current networks is preferred to more explorative initiatives (Baum & Haveman, 1997; Gimeno *et al.*, 2005). As the exploitation continues, above-normal returns are competed away (Haveman, 1993). Localised search and learning with capability development processes builds a situation in which a firm's behaviour leads to similar competitive search (Barnett & Hansen, 1996; Noda & Collis, 2001). If firms compete intensively against each other, the benefits of competition flow to other participants, e.g. suppliers and customers. The continuing 'Red Queen' competition leads to the deterioration of the focal firms, while the business system is advancing rapidly (Barnett & Hansen, 1996). The summary of evolutionary and ecological approaches is in Table 1.

Table 1 Evolutionary and ecological implications to network market investigation

Item	Evolutionary emphasis (positive feedback mechanism)	Ecological emphasis (negative feedback mechanism)
Main focus	Retention and adaptation (Nelson & Winter, 1982; Nelson, 1998)	Selection (Hannan & Freeman, 1977; Carroll, 1984)
Source of advantage	Cumulative advancement suited to environment demands (Nelson & Winter, 1982; Nelson, 1998); Inimitable resources (Barney, 1991); Learning e.g. (Penrose, 1959)	Central position in an uncrowded, viable niche (Podolny & Stuart, 1995; Podolny et al., 1996)
Key competitive actions	First-mover actions (Katz & Shapiro, 1986b; Lieberman & Montgomery, 1988; Besen & Farrell); Adaptation to environment (Nelson & Winter, 1982; Nelson, 1998); Managing expectations (Besen & Farrell, 1994)	Actions repeat organisation's former pattern, which is similar to patterns found with other surviving firms (Hannan & Freeman, 1977); Imitation if one has to explore (Haveman, 1993; Mezas & Lant, 1994; Greve, 1996); Imitative responses (Barnett & Hansen, 1996)
Relationship to other firms	Source of support as well as competition (Wade, 1995); Co-evolution (Baum & Singh, 1994a)	Competitive if occupying the same niche resource-space, or using similar resources (Hannan & Freeman, 1977; Carroll, 1985; Barnett & Carroll, 1987; Barnett, 1990; Baum & Singh, 1994b).; A source of legitimacy in a new market (Carroll & Hannan, 1989b; Haveman, 1993)
Source of change, conflict, crises	Internal, or internalised (Nelson & Winter, 1982) (Meyer, 1990; Singh, 1990; Meyer, 1994)	External as the niche becomes unsupportive or over-crowded (Meyer, 1990; Singh, 1990; Meyer, 1994).
Mechanism of positional change	Positive feedback loop leading to divergence (Arthur, 1990; Dickson et al., 2001; Noda & Collis, 2001)	Negative feedback loop leading to firm convergence (Noda & Collis, 2001) ¹⁶

¹⁶ Researchers studying product attributes and strategies in network environment use different terms to describe similar issues. Categories of positive and negative feedback (Arthur, 1990; Dickson *et al.*, 2001) bear resemblance to the classes of a firm's institutional and technological strategies (Das & Van de Ven, 2000), extrinsic and intrinsic product strategies (Lee & O'Connor, 2003), or external/market related factors compared to internal factors (Ehrhardt, 2004) in choosing a competitive strategy. All of them investigate the evolution of industries, firm strategies, and networked products. While the last three emphasise the difference between the network related and product related attributes, the first emphasises the difference on the end-states of competition. Negative feedback is an equilibrating regularity, while positive feedback is feeding itself (Dickson *et al.*, 2001).

For Noda and Collis (2001), an economic, socio-political or social network, and cognitive positive feedback create divergent forces, while imitation is a source for convergence (Noda & Collis, 2001). Simulation study by Oliva et al. (2003) showed that strong growth strategies for new entrants are very vulnerable. The same positive feedback mechanisms that power the growth can become vicious cycles if there are constraining factors, e.g. low quality in product offering

that leads to customer churn or inadequate infrastructure (Oliva *et al.*, 2003). Another example of a vicious circle is a fall in sales which leads to a raise in price because of the cost structure. The raise in turn leads to a further fall in demand (Dickson *et al.*, 2001).

3 RESEARCH DESIGN

The chapter explains the methodological choices and case setting of the study. The chapter provides justification for the use of the case research method (e.g. Yin, 2003). Later, it provides arguments for why the particular case was selected for scrutiny. It is followed by a description of the different analyses used to investigate the case evidence. Finally, the chapter discusses efforts to ensure the reliability and validity of the study.

3.1 Case study as a research strategy and a set of analytical tools

3.1.1 *Motivation for case study method*

The case method was selected after deductive logic hypothesis testing was judged to be impractical. There are three overlapping reasons for selecting the case study method for this particular topic.

Firstly, the character of available data makes large-scale hypothesis testing improper. This dissertation follows Yin's (2003) definition of case study research strategy, in which a case study is used to empirically investigate a contemporary phenomenon within its real life context, especially when the context and boundaries of the investigated phenomenon are not clear-cut (Bonoma, 1985; Jensen, 2002; Yin, 2003). The dynamic nature of a networked market with various feedback mechanisms makes an investigation of adoption and competition issues difficult. Dynamic competition offers a multiplicity of possible variables, but few even potentially similar markets for comparison. The case study incorporates more variables of interest than data points, relies on multiple data sources, and benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin, 2003). The research area involves all of the above, which was one motivation for using a case study methodology.

The evolutionary and ecological frameworks have been claimed to be most applicable over long time periods (e.g. Aldrich & Pfeffer, 1976). Barron (1998) argues that the mainstream research strategy suffers from some drawbacks. Covering long periods

would limit the possibilities to study particular periods in the organisation's development. In addition, qualitative historical sources add depth to the analysis and provide an alternative means of analysing the impact of the investigated variables (Barron, 1998). The selected timeframe can be evaluated as being critical to the particular network's evolution, supporting the methodological choices. There is a strong tradition of favouring using one or few in-depth industry cases when investigating the relative importance of feedback mechanisms and competitive actions during a transformational period (e.g. Tushman & Anderson, 1986; Barron, 1998; Rindova & Fombrun, 1999; Afuah, 2000; Kauffman et al., 2000; Klepper & Simons, 2000; Murmann & Homburg, 2001; Gallagher & Park, 2002).

The second reason for favouring a case methodology concerns the merging of different research conventions. The dissertation uses concepts, ideas, and findings from research traditions. Even with theoretical (Suarez, 2004) and observed bibliometric links to the network externality discussion, the applicability of evolutionary approaches to the network externality concepts and context is not clearly established. For example, network externalities have not been seen as relevant when studying business processes (Kauffman & Walden, 2001). As these fields are clearly developing, more explorative work is needed. A case study provides a possibility to examine further whether evolutionary ideas and findings apply also in the context, and in relatively short time periods.

The third reason relates to the openness of the research structure. My objective is to evaluate how the evolutionary perspective on economics and population ecology explains firm strategies for the competition in this context. A hypothesis-testing setting would have imposed severe restrictions on available results, and their validity. A case study as a more exploratory venture is suitable if a researcher wants to be open-minded about unanticipated results. In addition, one of the objectives of the dissertation is explanation building, which can be performed by a case study (Cunningham, 1997; Yin, 2003).

One point of criticism is that case study terminology is rather vague. The term case method, case research, or case analysis has different definitions, whereas in Yin (2003), above, there is only one. Bonoma (1985) defines a case study as a description of a management situation, while for Eisenhardt (1989) a case study is a research

strategy, which focuses on understanding the dynamics within single settings (Bonoma, 1985; Eisenhardt, 1989). In fact, the endeavours required to provide process models of organisations most often derive from case studies (Bryman, 1992). Case study research and grounded theory use partially overlapping terms (Mäkelä, 2004). A baseline design in grounded theory research is to make inductive inferences. Eisenhardt (1989), notably, has suggested that the case study can be used as an inductive method for theory building (Bonoma, 1985; Eisenhardt, 1989). Glaser and Strauss (1967) underlines that a researcher brings his past into the research, but warns “of too strict adherence to existing theory” (Glaser & Strauss, 1967). As a researcher I have tried to remain sensitive to the new emerging insights that the data offers (Glaser & Strauss, 1967), while explicitly acknowledging the role of prior theorising (Strauss, 1987; Cunningham, 1997; Yin, 2003).

A historical method, as in Golder (2000), bears great similarities to the case study research. This dissertation has paid attention to data informant quality, borrowing from the methodological advancement of historical methods (Golder & Tellis, 1993; Tellis & Golder, 1996; Bedeian, 1998; Golder, 2000; Gallagher & Park, 2002). After discussing with historical methodologists, it seems clear that the dissertation follows more closely to case study traditions. Case studies make an effort to answer ‘how’ and ‘why’ questions, which contrasts with many historical studies (Yin, 2003). The case study may have a prior theory to work with (Yin, 2003), while historical methods start by selecting a topic and collecting evidence (Golder, 2000). The difference is subtle, as some historians advocate formulating hypotheses before data gathering (e.g. Savitt, 1980).

Case study methodology has been claimed to have difficulties in conveying the trustworthiness of results. Case research concepts and techniques to meet demands on reliability, replicability, and external validity are not fully developed, despite significant efforts (Numagami, 1998). Case study as a research methodology has been criticised mainly for the problems of generalisation (Eisenhardt, 1989; Tsoukas, 1989; Bryman, 1992; Yin, 2003). Numagami (1998) stated that reliability, replicability and external validity should be pursued only if the search was on a universal and invariant law. However, the assumption of the existence of invariant laws in social science differs can be doubted. The regularities are often a result of human conduct, and

human beings are able to reflect on acquired understanding, leading some of the regularities to perish. According to Numagami (1998), this reduces the role of reliability, replicability and external validity. For Numagami (1998), the aim of research is to guide discourse, and there is no need to find law-like regularities (Numagami, 1998). A less radical view is that case study offers a theoretical generalisation but it does not offer a possibility to infer findings from a sample apply them to a population (Yin, 2003). For some methodologists (Eisenhardt, 1989; Yin, 2003), the quality of case research can be judged on how it has met the requirements of different aspects of validity and reliability. Tsoukas (1989) offers a different view on how to value explanatory case studies. In realist epistemology, explanatory idiographic studies are in a position to make general claims about the world. For a realist, event regularities are not necessarily an identification of a causal law, and so, e.g., replication itself does not offer generalisability. Idiographic explanatory research, such as case studies, sheds light on the specific contingent conditions under which the postulated generative mechanisms operate (Tsoukas, 1989).

3.1.2 Case study design

The general analytic strategy in case research helps to define further analytical work (Yin, 2003). In the study, the general strategy involves definition and testing of rival explanations, especially rival theories (Yin, 2003). All of the rival explanations do not have to be included in the beginning of the research process, but may become apparent during the course of research, as happened also in this study. In comparison to the hypothetic-deductive method, the inclusion of rival explanations is even desirable (Yin, 2003).

The dissertation is both exploratory and explanatory. The research is conducted as a single-case study, which is appropriate both for testing a well-formulated theory, or in exploratory studies (Yin, 2003). An element of multiple-case study has been included in this dissertation. A nomological map is constructed that serves as an initial, or theoretical case (Yin, 2003). Following Cunningham (1997), the approach used here can also be described as a comparative case study. After investigating the differences between the case and the nomological map, the map is revised.

The case analysis comprises qualitative and quantitative information, involving different analytical tools (Bonoma, 1985; Eisenhardt, 1989; Bryman, 1992; Cunningham, 1997; Yin, 2003). New sources of information were added during the course of research in order to improve quality. The case study is a flexible method giving the freedom to make adjustments during the data collection process (Eisenhardt, 1989). Network analysis and structured content analysis was used to complement historical analysis, and in the course of work, interviews were added to triangulate findings and gain additional insights. In the process of answering my question, I found it necessary to get more definitive answers from my set of qualitative data. For a new and smaller set of questions, I turned to qualitative comparative analysis (QCA), which offered a methodology to evaluate comparable events (Ragin, 1987; Ragin, 2000).

3.2 Research setting

A case study involves theoretical sampling or rationalisation, instead of statistical sampling, or random selection of cases (Eisenhardt, 1989; Yin, 2003). Miles and Habermas (1994) suggest sampling parameters such as settings, actors, events and processes.

Table 2 Summary of the methodological choices of the study.

Sampling parameters	Choices
Settings	Introduction of new technology in television broadcasting in the United Kingdom
Actors	Firms and their managers, consumers, regulatory bodies and their key personnel
Events	Market entry, exit, managerial actions (channel listing, partnering), regulatory actions, announcements about them
Processes	Competition, imitation, diffusion, evolution

Applied from Miles and Habermas (1994).

The dissertation has an embedded case design, as the analysis includes the outcomes of different organisational levels. Holistic case design would instead concentrate only on a single level of analysis (Yin, 2003). The main level of analysis is a firm, and the

three other levels are the market level, the firm network level, and the managerial level. The actors are managers active in their firms, consumers, and personnel with administrative powers in regulatory bodies, such as the government or European Union, but also in industry associations.

Case research studies should carefully consider the justification of that particular case. Yin (2003) compares different kind of case studies based on their rationales. The choice does not fit into only one decision criteria. However, the selection here mostly follows a critical case rationale, because the case is confirming or challenging the previous work on the issue, and also extending the applicability of theoretical work in this context (Yin, 2003). The intensity of the markets contributed to the surfacing of elements, which could not have been observable in other settings. At the same time, the chosen market has a value also as a unique case, because it was the leading market in this field at the time of study (Duffy et al., 1998). The industry represents a typical case rationale, because previous researchers (Gupta et al., 1999; Shapiro & Varian, 1999a; Le Nagard-Assayag & Manceau, 2001) have argued that the selected industry is representative of networked markets.

3.2.1 Choice of industry

The setting of the initial case is the transformation from analogue to digital television broadcasting. From the perspective of networked business systems dominance, the transition to digital television technology provides a setting for a typical case. There are four main reasons for this. Firstly, the digital television industry provides a classical case of indirect network externalities. Each additional network member - be it a new digital channel, interactive digital service provider, or a digital television viewer - raises the value of the television network both directly and indirectly (Shapiro & Varian, 1999a). Direct network effects are, or will be present when interactivity is provided and the viewers can reach other viewers in a similar manner as through telephone networks. Indirect network effects are present when the increasing number of viewers makes it more profitable for new content providers to join. Gupta (1999) modelled how indirect network externalities are a major factor influencing market penetration of digital television (Gupta *et al.*, 1999). Boardman and Hargreaves (1999) showed that the network externality apparatus is also useful to evaluate the value of particular programs. Consumers may feel that watching a

popular program is worth more because they can discuss it in different communities, while smaller isolated audiences do not enjoy network benefits. For example, an increase in the number of viewers of sporting events adds both to the value of the event and the broadcasting network (Boardman & Hargreaves-Heap, 1999). Secondly, the digital television broadcasting industry involves several independent, but intertwined firms providing complementary products and services (Gupta *et al.*, 1999; Papathanassopoulos, 2002). Thirdly, there is a multi-layer race for de-facto standards since it is believed that the market cannot support many designs (Papathanassopoulos, 2002). There is competition between different means of transmission – satellite, terrestrial, and cable – and between different receiver technologies used to receive digital signals. In addition, there is competition among the digital television-broadcasting firms and among complementors that create content for the digital television broadcasters.

3.2.2 Choice of market and timeframe

The researched events took place between 1998-2002 in the United Kingdom. The visibility of the competition provides the reasoning for the case to be classified as a critical case. The intensity and publicity of competition in the U.K. digital television market helped to surface aspects in competition that might be more difficult to detect in more static settings. The basic assumptions set by the network externality theorists are well met by the particular case. However, intensity will bring about series of actions and counter-actions that have been outside of the scope of network externality theorists more familiar with economic modelling.

The country specific setting also provides unique features, because of the pioneering role the market has taken in the diffusion of digital television. The U.K. has been a leading digital television market in the world (measured by penetration in households and by the diversity of channels). The United Kingdom was the first country to have digital television in three forms, satellite, aerial, and cable (Duffy *et al.*, 1998).

The industry includes different types of firms, and the dissertation discusses the importance of various complementary firms. The empirical investigation is largely focused on four commercial platforms. The initial focus was later widened to include

British Broadcasting Company (BBC), because of its importance to most aspects of U.K. television.

The researched period, of 1998-2002, focuses on Suarez's (2004) phases III to V of the technology dominance process. The beginning of the researched period was the launch of digital television in the U.K. consumer market, which Suarez (2004) describes as the beginning of Phase III, 'creating the market'. In Phase IV a 'decisive battle' starts as a clear early front-runner appears, and ends when one alternative design becomes dominant, starting phase V, 'post-dominance' (Suarez, 2004). In terms of population ecology, at the end of the study period only one of the major service providers had not been selected out by elimination, as all of the major competitors went through radical transformation, or into bankruptcy (Carroll, 1984) in 2002. The research period covers the competition from the launch to market domination. The industry structure has kept evolving since 2002, but later developments are outside the scope of this dissertation.

3.3 Source of data and analyses

3.3.1 Use of archival data

Using Yin's (2003) classification, the data collection used here includes documentation, archival records and interviews. The starting point of the study is documentation material, because of the distortions in retrospective informant data. Bernard et al. (1984) reviewed research on informant accuracy and summarised the findings by stating that half of what informants report about past events, behaviour or circumstances is probably incorrect in some way (Bernard *et al.*, 1984). More specifically related to studies on strategy, informants are argued to have difficulties in describing ex-ante perceived decision-making contexts in different points in history (e.g. Golder & Tellis, 1993; Tellis & Golder, 1996; Das & Van de Ven, 2000; Golder, 2000; Gallagher & Park, 2002). In response to such criticisms, the market entry studies of Golder and Tellis (1993, 1996), Golder (2000), the network competition study of Gallagher and Park (2002), and the strategy process study on technology competition by Das and Van de Ven (2000) used unobtrusive data sources and analysis. Tellis and Golder (1996) argue that surveys or interviews with current survivors may be considered retrospective, and respondents rely on personal recall or

the oral tradition of the firm being surveyed. They propose using information that has been written or recorded when the events have actually occurred. The second advantage of the historical data gathering methodology stems from the possibility of using multiple narratives of neutral observers, such as reporters, experts, and students of the market. Firm managers tend to focus on positive aspects of action, which can be balanced by scrutinising other media reports (Rindova & Kotha, 2001). Using several kinds of data, the approach is more likely to collect data that is factual rather than interpretive (Tellis & Golder, 1996; Das & Van de Ven, 2000; Golder, 2000).

Firm strategies can be investigated by evaluating series of observable actions by interacting organisations (Bettis & Weeks, 1987; Smith et al., 1991; Chen et al., 1992; VandeVen & Garud, 1994; VandeVen & Poole, 1995; Ferrier et al., 1999; Das & Van de Ven, 2000; Ferrier, 2001). The public knowledge of these actions relies on the publicly available information recorded at the time that the events occurred (Das & Van de Ven, 2000). The strategy is operationalised using retrieved firm announcements or reported news stories. I performed analyses that relied on publicly available event data, published by the business system participants. Using news reporting and press releases at the time relieves the self-reporting biases associated with the sole use of informants.

Unobtrusive case data comprises qualitative information on news events, and numerical firm and aggregate level performance data. The recorded unit in each case database is an event representing a news item or an announcement about a firm. Alliance announcements and new digital channel introductions by any of the actors active in the introduction of the digital television system in the United Kingdom provided firm network analysis data. The statements or quotes by persons were used for content analysis. The principal news information sources were the Digital Television Group's news archives, read and filed from site www.dtg.org between summer of 2002 and January of 2003. The group is an industry-wide organisation sponsored by the companies involved. A trade journal as a source has the advantage that it can cover more industry items than a general public newspaper (Smith et al., 1991). Channel line-ups were recorded from annual reports and separate announcements. Each event was entered into research database. Care was taken to crosscheck the events and their timings from multiple sources e.g. the Media

Guardian newspaper (paper and internet versions), Advanced Television's news archives, trade association papers, and trade journals, as well as Internet newsletters, interviews, and company internet sites. Internet discussion forums gave information about, e.g., when the companies did not fulfil their promises on channel delivery. The reported events included texts that were not directly comparable to each other e.g. product announcements written by public relations officer, and critical comment by a journalist. Trade associations and government agencies provided important supplementary data including, among others, the quarterly subscriber figures. Annual and quarterly reports by the major firms provided figures on subscription and financial data.

3.3.2 Interviews

Unobtrusive, historical data gathering offers only a partial explanation. Shortcomings include the invisibility of intentions that were not communicated to the public; not every event is reported and often the motives of the original reports remain unknown. Van de Ven and Garud (1990) describe that events captured in field-research represent a sample of indicators describing what happened over time. They are neither a population nor a random sample. It is necessary to compensate for these limitations by conducting interviews and gathering additional information (VandeVen & Garud, 1994). Van de Ven and Garud's (1994) article on the co-evolution of technical and institutional events analysed individual events in the unfolding of processes. Their historical narrative of a cochlear implant told a story in which no single event and no single process was sufficient to explain industry emergence (VandeVen & Garud, 1994). Similarly, interviews were used here in helping to create a narrative, and served also for data triangulation purposes (Cunningham, 1997; Yin, 2003).

Interviewees were selected based on information given by academic experts and information provided by company Internet sites. Only those prospective interviewees that represented 'public interest' i.e. government, or other regulatory bodies, a public broadcasting company, or a consumer association were willing to be interviewed. The above institutions seemingly use each other as a pool for recruitments, which can be seen from the individual careers paths of the interviewees. As the interviews were used to improve reliability, the problem of bias was reduced. There were four open-ended interviews carried out in November-December 2004. The interviewees had

been in managerial and expert roles at the time of the interview and the investigated period. Interviews lasted from 1 to 2 hours, and were conducted at meeting rooms with no other people present. The interviews were recorded with interviewee permission and transcript verbatim. The information received from the interviews reached saturation, which may partly be due to their late usage in the research process (see appendix 7.6.1 on case protocol).

The corporate executives of privately owned companies have been reluctant to be interviewed on this issue. The reasons could be an unwillingness to assist research with no clear financial benefits, and the desire to leave behind, or ‘forget’ some aspects of competition (Goodwin, personal communication, 2005). If the latter is an issue, it does not have an effect on the importance of the topic, but raises problems with bias of the available data. The private corporate view was added by using secondary interview material. In an academic book section, Goodwin (2005) gives a detailed account of digital terrestrial television, interviewing one major executive. In a book, Horsman (1998) focuses on the satellite platform, interviewing several important actors. Both of them quote interviewed people, and their published texts were used in this dissertation as well.

3.4 Analyses

3.4.1 Analyses of archival data

The original unobtrusive case database was used for three analyses. Firstly, it provided material for qualitative inspection of material that was present in the public arena. The aim was to understand the structure and dynamics of the market. Secondly, the events were recorded for social network analysis. That used dichotomised data on firms and dyadic relations. Thirdly, the statements or quotes were used in content analyses.

As mentioned in the literature research section, social network analysis methods have come to mean a set of mathematical and visual techniques for analysing and visualising the positions and relations of actors in networks, as well network structures (Borgatti & Everett, 1997; Venkatraman & Lee, 2004). The focus is on the attributes of pairs of individuals. These include the distances and similarities of the

participants (Borgatti & Everett, 1997). Centrality based measurements are of major importance in social network analysis, because a central actor in a network has a good access to information, status, power, prestige, or influence (Freeman et al., 1991; Friedkin, 1991). Also, a central actor can be thought to be between different paths of communication (Freeman, 1977; Freeman et al., 1991). An actor with a high betweenness value may facilitate, or limit communication between the nodes of its linked points (Freeman, 1979).

Social network analysis has also long been an established practice for analysing the behaviour of organisational actors in a networked business system (Oliver, 1988). For the purposes of this study, I analyse the relative structural positions of the main actors in the network and the changes in network structure over time. I perform analysis by constructing industry matrices for each of the five years from 1998 to 2002. In the adjacency matrices, columns and rows represent each firm. An entry in a cell represents the establishment of a link between two firms. Entries comprise both the digital line-up of the major platforms, and digital alliance announcements reported in trade journals. I used the Bonacich measure of power centrality (Bonacich, 1972, 1987) to track the digital television industry actors' changing network position. Data included channel listings and co-operative announcements, which makes cross-sectional comparison unfruitful. Comparison between firms can be done only on firms that have similar behaviour on announcing channels and other agreements.

Content analysis was used to make inferences from the data about their context (Krippendorff, 1980). I used content analysis for two separate analyses. The description of the quantitative analysis of news stories and announcements follows here, while the analysis for investigating interview data is described in the next chapter.

My quantitative analysis of media texts can be classified as discourse analysis, as I was interested in characteristics of manifest language, and word use (Neuendorf, 2002). The purpose of this analysis was to check the robustness of results from the other investigations.

Content analysis using newspaper sources has been used in various fields in social sciences, including firm strategy research (Jauch et al., 1980). The public statements

are intentional, and they are signalled to other network participants. The media disseminates and produces a common body of knowledge available to and used by firm managers (Hambrick, 1982). The media has also an important role in linking firms with stakeholders, in the process building industry macro-culture (Rindova & Fombrun, 1999).

I retrieved news stories and firm announcements including quotations by managers, which were dichotomised based on the evaluation of the perception of competition. The focus was on signalling action events, which are part of the competitive action repertoire (Ferrier et al., 1999; Ferrier, 2001). A more fine-grained classification seemed improper because of the relatively small number of cases. More importantly, most reported actions can be seen as signalling, which is theoretically an interesting concept for this dissertation. The publication of a retrieved statement was usually dated for the same or following day after the act of stating.

The news stories, firm announcements, quotations, and other data were also used for qualitative comparative analysis (Ragin, 1987; Ragin, 2000). The investigated case embeds smaller comparable events (Yin, 2003) which were analyzed using the Boolean logic approach of QCA (Ragin, 1987). QCA used binarised data on conditions leading to a specific outcome. The mini-cases were different competitive topics found in the earlier stages of the research process. Following the QCA argument, the cases are as configurations of conditions (Ragin, 1987). In this research these different configurations were different conditions leading to a specific type of competitive behaviour. The set of smaller comparative cases are embedded in the larger case.

3.4.2 Analysis of interviews and other texts

Qualitative reading of the acquired material was used to look for unifying themes or patterns (Cunningham, 1997) in four open-ended interviews and with two complementary additional texts. I used open coding to code transcript data, and worked with Atlas.ti text analyzer software. Here I was interested in the characters in the story; their difficulties, choices, conflicts, complications, and developments, which are described as being part of the narrative stream of analysing texts (Neuendorf, 2002). In coding the interviews, I followed an inductive ‘constant

comparative method' (Glaser & Strauss, 1967), whilst acknowledging the guiding role of my earlier work on the problem.

I coded the text after other data gathering had been done. I looked for words and sentences commenting or evaluating issues, which I had found potentially important in the earlier data gathering. The items related to competitive dynamics, network externalities, and to firms' idiosyncratic differences. As I tried to remain open to emerging concepts, I aimed to sense the different significance that the various data sources gave to the concepts. Texts in interviews emphasised some aspects that were observable in earlier retrieved texts, but the interviews gave them different importance. Following Strauss (1987), the axial coding was followed by selective coding. The categories were merged, and abstraction level was raised. Finally, relations among different categories were established (Strauss, 1987). Raising abstraction and linking the new higher-order categories involves researchers' imagination and understanding on the subject, as the interviewed persons did not express their views on them explicitly.

The case narrative was written several times after the original case data was compiled. I wrote new versions to reflect revised understanding of the case, in preparation for the interviews, and after the interviews and their categorisations.

3.4.3 Reliability and validity

Researchers frequently evaluate the quality of case studies, considering four separate aspects. The commonly used tests include construct validity, internal validity, external validity and reliability (Yin, 2003). Construct validity is about establishing the correct operational measures for the concepts. This study used the proposed (Yin, 2003) methods to meet the criteria: using multiple sources of evidence, establishing a chain of evidence and having a key informant review the case findings. Multiple sources were the different archive materials from different sources, and interviews. A chain of evidence is established with the following procedures. First, the case report cites specific documents, observations and interview (Yin, 2003). Second, an outsider can inspect the actual evidence i.e. interview tapes, and retrieved documents, and find information on the circumstances of data collection (Yin, 2003). Third, the circumstances are coherent with the data protocol in relation to interviews (Yin,

2003). In relation to document retrieval and analyses, the procedures are written down in research diaries as decisions and actions were made. The fourth issue on the chain of evidence is about the link between the protocol and initial study question, which should be established in a clear manner (Yin, 2003). The protocol written for the dissertation has a lesser value in the study, compared to studies where a researcher followed the strategy right from the start. The reason for this is that the case research strategy was selected in the course of the study, not at the onset. Therefore, a formal case study protocol was not produced at the beginning of the research. Research diaries were written from the beginning. Comments on the narrative made by an informant were evaluated and modifications were made.

Internal validity is about establishing causal relationships, distinguished from spurious relationships (Yin, 2003). The use of explanation-building and the logic model, and addressing rival explanations were part of effort to deal with that test (Yin, 2003). A section is devoted to qualitative comparative analysis (QCA), which is grounded in Boolean algebra of logic and sets. It offers tools to analyse complex causation paths with a small to medium number of cases. By evaluating the observed and logical combinations of conditions leading to outcomes, the comparative method offers a way to summarise data and to evaluate its coherence, and to test a hypothesis and assumptions (Ragin, 1987; Ragin, 2000).

External validity requires establishing the domain to which the findings can be generalised (Yin, 2003). An extensive literature review helped to surface the relevant theoretical work, advising on the external validity (Yin, 2003). But, the theoretical literature is negotiated along the research process. There are new instances in which a researcher is evaluating the evidence, and new findings may alter the earlier theoretical understanding. The simultaneous work on theory and replication follows guidelines on carrying out research under a realist paradigm. Tsoukas (1989) suggests that a study should deal with abstraction and theoretical conceptualisation, while at the same time investigate the existing contingencies and their interaction with the postulated mechanisms (Tsoukas, 1989). Reliability involves demonstrating that the operations of a study can be repeated with the same results (Yin, 2003). Data was collected and evaluated by a single researcher, increasing the risk of poorer reliability. The problem was addressed by using a case study protocol and developing case study

databases (Yin, 2003). A case study protocol was created well before the interviews; see appendix 7.6.1. A case study should also involve a running commentary on the work. The purpose is to manage the overlap of data collection, coding, and analysis (Eisenhardt, 1989). Therefore, separate research diaries were created for three separate phases of data collection and analysis. The diary was used to list the choices made during the process. The aim was to improve reliability, as some categorisation decisions were based on subtle differences found in the material. In addition, field notes were taken to assist memorising researcher impressions from the interviews, separately from the discussion in the interviews (Eisenhardt, 1989). These field notes were included in the interview diary in the 24 hours following the interview.

Events included in the research database represent both announcements by the participant firms and trade journalists' reporting. The published texts were said or written close to the time of publication, which is typical material for media organisations to gather and distribute, improving the quality of the material (Krippendorff, 1980). The material represents different sources of biases. First, there is a bias by the business system participants to overemphasise the importance of each new channel and alliance introduction. Firms want to publish good news more eagerly than bad news (Das & Van de Ven, 2000). In order to avoid the problem, crosschecking from other data sources was used where possible. Das and Van de Ven (2000) argues that competitors and government agencies provide information contrary to the initial firm when necessary (Das & Van de Ven, 2000), balancing the bias. Internet discussions are also a forum to deal with perceived problems. In addition, a simple recording procedure in social network analysis was adopted to avoid the judgmental problems. Therefore, the events in the original case material using the event data were recorded with equal weight. This was done simply by registering them as new network elements to the network. The procedure prevented the major difficulty in separately weighing the relative significance or 'the worth' of each alliance announcement. However, there could be some bias the other way round. It is likely that some of the recorded events were more important than others, biasing the resulting network structure in favour of minor events. Fortunately, the bias can be eliminated with a qualitative analysis of the business system evolution, which can show the importance of particular events. For this study, interviews were conducted to evaluate the need for additional indicators, and for triangulation purposes

(Cunningham, 1997; Yin, 2003). Triangulation tests external validity, but the interviews may also capture a more holistic view (Jick, 1979) than reported news items.

Another source of bias is that different companies have different policies for announcing their alliances or new channel introductions. This would be a problem for an investigation on artefacts. But, technology can be seen as a social construct, including both the artefacts and knowledge (Das & Van de Ven, 2000). The articles and channel listings are a proxy for the social reality of the digital offering that influences competitive reactions and customer behaviour.

4 DIGITAL TELEVISION CASE

This chapter describes competition in the commercial television market in the United Kingdom with the arrival of digital television. The histories of television and leading firms are presented for a better comprehension of the competitive dynamics among the focus firms. The chapter continues with a case narrative covering the period of 1998-2002, evidencing the competition for network dominance. The narrative is complemented with a social network analysis of relationships between the actors, content analysis of published statements and news events, and qualitative comparative analysis on competitive topics.

4.1 Technological setting

4.1.1 History of broadcasting

An Italian, Guglielmo Marconi, discovered the possibilities of earlier inventions and developed radio in 1895. He moved to England where he could better demonstrate the potential of radio waves as a means of wireless telegraphic communication. The effort succeeded and radio broadcasting started in 1920. From the beginning, the authorities of United Kingdom showed an interest in regulating the broadcasting industry. By comparison, in the United States, very liberal entrepreneurship resulted in 50% of radio stations failing within a few years. The U.K. government allowed the first experimental radio stations to start in 1922, which was also the year that the British Broadcasting Company was formed (Cook *et al.*, 2001; BBC, 2004j, 2004d).

In 1936, a BBC Television service was launched, albeit tentatively. Commercial television service began in 1955 as a group of separated regional franchises, which later formed a national network system, ITV (Cook *et al.*, 2001). Terrestrial transmission was the major means of television program delivery. From the beginning of British television, there were ventures cabling blocks of apartments for program distribution, which used the signal from a master antenna at the roof-top (Caldwell, 2001). The first direct-to-home analogue satellite service began operating in 1989 (Ghemawat, 1997; BBC, 2004g; National Museum of Photography, 2005).

The industry was highly regulated until the 1990's (Boardman & Hargreaves-Heap, 1999; Cook *et al.*, 2001; BBC, 2004g). Independent broadcasters were regulated by

the Independent Television Authority, which later became the Independent Broadcasting Authority, following the introduction of commercial radio. At that time the IBA, as a public authority, acted as 'the broadcaster' which granted the franchises to the individual television companies (ITC, 2003).

New regulations suggested by the Peacock Report of 1986 meant that ITV franchises were given to the highest bidder, above some quality threshold, and that television broadcasters had to buy at least 25% of their content from independent companies. This led to the emergence of new companies, whilst the BBC and some of the ITV companies were forced to downsize their organisations (Cook et al., 2001).

The new regulations can be seen as instruments to deal with the globalisation of television programming. The upsurge of television channels and broadcasted hours increased demand for program content, which has widely benefited U.S. producers (Cook et al., 2001). New alliances, and exploring new ways to produce and distribute content, are a means to deal with escalating production costs (Cook et al., 2001).

The Department for Culture, Media and Sport is the supervising ministry of the industry. In the study period, the follower of the IBA, the Independent Television Commission (ITC) awarded licenses to non license-fee, or non-government funded television operators in the UK, and regulated these services through its licenses and codes of practice on program content, advertising, sponsorship and technical standards (ITC, 2003). ITC handled complaints about programs or advertisements on ITV, Channel 4, Channel 5, satellite and cable television, or commercial radio. The BBC was primarily a self-regulating institution. However, Broadcasting Standards Commission (BSC) processed complaints about violence, sex, and matters of taste and decency on any radio or television channel, or about unjust or unfair treatment or infringement of privacy (ITC, 2003). At the end of 2003, Ofcom replaced five regulators: the Broadcasting Standards Commission, the Independent Television Commission, Oftel, the Radio Authority and the Radio Communications Agency.

BBC channels 1 and 2, ITV3, Channel 4, and Channel 5 have been the dominant channels in traditional free-to-view television in UK. License fees cover the expenses of the BBC channels, while showing advertisements mostly finances the rest of free-to-view television. The introduction of digital broadcasting has changed the

competitive environment, with a great impact on traditional broadcasters (Cook et al., 2001).

4.1.2 History of digital television

Data compression makes it more efficient to deliver data, compared to the former analogue system. Digital television uses digital encoding and compression to broadcast video, audio and data signals to television sets. In digital television distribution, programs are encoded into a digital stream. Different streams are combined, or multiplexed, before being modulated and distributed to homes. Combined streams are received on a home set-top box. The set-top box separates streams, and decodes them into analogue for the standard television set. Television sets with integrated set-top boxes are also being offered (CompetitionCommission, 1999; Burg, 2003; DigitalTelevisionProject, 2004). As with the analogue system, television signals are transmitted on satellite, terrestrial and cable systems.

Standardisation of digital television (DTV) has been mainly based around two initiatives. The European-led effort is called the Digital Video Broadcasting or DVB Project. The North American initiative is organised by the Advanced Television Systems Committee, or ATSC (DVB, 2003; Wikipedia, 2005).

Digital technology in production has changed industry practices and ecology (Cook et al., 2001). Commercial television broadcasting consist of two markets, one for viewers and another for advertisers (Liu et al., 2004). The television value chain has traditionally consisted of three separate but sequential phases of value creation; namely content production, publishing or channels, and distribution. Research conducted at the time of the major commercial launches of digital television forecasted that customer interaction was an important new source of value addition. Digitalisation increases the number of ways in which customers are paying for their television (Duffy et al., 1998), suggesting the importance of pay-TV operators.

Digital compression of signals, and participants' views on the process, has started to restructure the industry. Digitalisation has opened up possibilities for freer entry to the broadcasting industry. The new opportunities are also a challenge for traditional television firms active in free-to-view markets, and especially public broadcasters

funded largely by license fees. Firms have challenges to cope with in financing their operations when there is more competition, and when much of the technology has had to be renewed. The technology has given an opportunity for new sources of income for the commercial actors e.g. interactive services, giving rise to interest from telecommunication companies, and restructuring of the pricing schemes of channels. In addition, the equipment needed for recording, storing, transmitting, and receiving material is different than in the former analogue systems, which has meant a demand for new manufactured goods (Dholakia et al., 1996; Hancock, 1998; Bajon & Fontaine, 2001; Cook et al., 2001).

4.2 Organisational setting

4.2.1 *BBC and Freeview*

The British Broadcasting Company (a public broadcaster) was formed in 1922 with strong involvement from Guglielmo Marconi and other manufacturers. The role of engineers was significant from the beginning, as was the role of editorial independence. The BBC website describes how the first general manager envisaged the company as “an independent British broadcaster able to educate, inform and entertain the whole nation, free from political interference and commercial pressure “ (BBC, 2004d). In 1927, the British Broadcasting Company became the British Broadcasting Corporation.

In 1936, the BBC Television service was launched, but geographically it served only a small area (Cook et al., 2001; BBC, 2004e). World War II interrupted the development of television broadcasting, whilst radio became ever more important. The company established a War Reporting Unit to cover the events. The BBC gained its worldwide reputation when, by the end of the war, radio programs were broadcast in 40 languages (BBC, 2004f)

The government guides the activities of BBC by setting regulatory and organisational frameworks. A Royal Charter constitutionally established the BBC in 1927, and each following charter has had a fixed length of approximately 10 years. The role of government is significant as it sets the general framework for where and how the BBC operates. The Charter with its accompanying agreement recognises the BBC's

editorial independence and sets out its public obligations. Formally the Queen, but in practice the government, appoints the Board of Governors that ‘act as trustees of the public interest’. The case study investigates events occurring at the time of the eighth Charter, covering the period 1996-2006 (BBC, 2004a, 2004c). The charters sets the limits of commercial ventures. BBC Worldwide was responsible for most of the corporations commercial activities in the UK and internationally. The subsidiary owned 50% of the UKTV subscription channels, with Flextech owning the other half (CompetitionCommission, 1999).

When digitalisation and other advancements in technology led to stronger competition, the BBC and the regulating authorities legitimised its role by creating the ‘Extending Choice’ mission, which was to offer a range of programs that commercially funded broadcasters would not provide (BBC, 2004h). The company gets its revenues primarily from license fees, the price of which is set by the government. The annual cost of a colour TV license was £121 in 2004 (BBC, 2004b).

The BBC has been in active in the digitalisation of television, and it has been present in different broadcasting platforms. When the terrestrial ONDigital/ITVdigital went bankrupt, the BBC led the effort to launch Freeview in 2002. The other partners are multiplex operator Crown Castle (formerly the BBC's transmission division) and BSkyB. Freeview is a digital aerial television service that offers channels without subscription fees. The channels of Freeview include, but are not restricted to, offerings from the BBC and BSkyB (BBC, 2004i; Freeview, 2005).

4.2.2 Commercially operating free-to-view channels

4.2.2.1 ITV (Channel 3)

The BBC television arm faced direct competition when commercial stations entered the market in 1955, following the Beveridge Report of 1951. The commercially funded alternative, with public service obligations, was established as a network of regional firms. Independent broadcasters were given a fixed term regional monopoly to show television programs with advertisements. A separate company ran each region, and commercials were not allowed to be sold nationwide. The franchise owners were allowed to make a profit. The broadcasters had public service

requirements, including showing regional content. These obligations were stated in the terms of their licenses from the Independent Television Authority.

The franchise system required co-operation, and the broadcasters formed a national network system, although regulations forbade them from merging. The composition of the original Independent Television broadcasting companies did not see major changes until the Peacock Report of 1986. This suggested competitive tendering for ITV franchises with a quality threshold. The implementation of the suggestions of the report weakened the strong position of the original ITV broadcasters (Cook et al., 2001). The free-to-air ITV channels have been popular, e.g., in 1998 ITV (channel 3) had 38.0% of peak time viewing, compared to 31.6% for BBC1.

4.2.2.2 Channel Four and Channel Five

A new nationwide advertisement funded channel was launched in 1982. The license terms of Channel 4 included public service requirements, e.g., offering programs appealing to audiences not covered by ITV (CompetitionCommission, 1999; BBC, 2004g). As a statutory non-profit-making corporation, it originally received its funding from advertisements. In 1998 it entered the subscription TV market by launching a movie channel on all digital platforms (CompetitionCommission, 1999). Advertising was also the source of income for Channel 5, launched in 1997. In contrast to Channel 4, Channel 5 is a privately owned company. The major shareholders of Channel 5 are UNM, CLT/UFA and Pearson (CompetitionCommission, 1999; Cook et al., 2001).

4.2.3 BSkyB

British Sky Broadcasting (BSkyB) was created as a result of 'war of attrition' (Ghemawat, 1997) between British Satellite Broadcasting (BSB) and Sky Television for dominance of the satellite television market in the U.K. In analogue satellite competition, BSB had made the first announcement about market entry, but Sky actually launched the service first, in February 1989. The financially weaker Sky used less advanced technology, but provided more channels and Hollywood-films, which were valued by viewers. BSB launched in April 1990, and remained behind in cumulative installations (Ghemawat, 1997). The cash-consuming broadcasters started to negotiate their way out of problems by a merger. In the month earlier BSB was

losing £6-7 million each week, and Sky about £2million. At the same time, Sky's parent company News Corporation was facing debt renegotiations (Ghemawat, 1997). The announcement of the 50-50 per cent joint venture was made in November 1990. The new entity, BSkyB, in reality gave an upper hand to Sky's owners and managers (Ghemawat, 1997; Chenoweth, 2002). One of the four owners of the BSB was Granada, a later rival in the competition for network dominance between different transmission platforms (Chenoweth, 2002).

Ghemawat (1997) explains the escalation of competition and the end-result partially by the behavioural characteristics of managers in News Corporation, especially the Australian-born founder Rupert Murdoch. News Corporation has been described as having 'one of the most aggressive corporate cultures in the world' with Murdoch having run the company as a one-man show for five decades (Chenoweth, 2002). He had bet all of his media holdings on the success of digital television in the U.K., but similar high-stake operations had taken place before (Horsman, 1998). Already in the late 1950's, Murdoch tried to get a local monopoly in broadcasting in Australia, but after failing to get such a concession, raced to become a pioneer in the market (Ghemawat, 1997). In 1962, News Corporation forced the winning Sydney franchise bidder to offer it a stake. News Corporation pressurised the franchise holder by announcing the launch of competitive broadcasting from nearby area, which would decrease the value of the franchise (Ghemawat, 1997). A power struggle between Murdoch-controlled newspapers and printing press labour unions occurred when Margaret Thatcher was the prime minister, which resulted defeat for the unions. The events changed the newspaper industry but the News Corporation's manoeuvres had not succeeded without political backing (Chenoweth, 2002). Rupert Murdoch's strong political influence has been seen both as a threat to politicians and as sign of ideological kinship (Ghemawat, 1997; Bajon & Fontaine, 2001; Chenoweth, 2002). Mr. Murdoch has described the traditional UK broadcasters as elitist, distancing himself from the cultural establishment despite his own Oxford-education (Ghemawat, 1997; Horsman, 1998; Chenoweth, 2002).

BSkyB was a profitable as an analogue operation, but preparations for digitalisation altered this situation. Quarterly results announced in November 1997 showed a decline in profits for the first time since 1992 (Horsman, 1998).

4.2.4 ONDigital/ITVdigital and its owners Carlton and Granada

ONdigital was originally a joint venture named British Digital Broadcasting (BDB). It was to have been led by BSkyB, Carlton and Granada, but due to competitive reasons, the Independent Television Commission (ITC) would not have given a license if BSkyB remained in the alliance. The ITC view was encouraged by the European Commission, and BSkyB was forced to leave the consortium (CompetitionCommission, 1999). The investment community reacted strongly to the break-up, a quarter of the value of BSkyB was lost in a week (Cool *et al.*, 2000). The departure of BSkyB led to, e.g., intense disagreements between the companies about payments for programming (Chenoweth, 2002), hostilities which began before the study period.

Two of the most prominent ITV companies, Carlton and Granada, launched the pay-TV platform ONdigital in late 1998, each with a 50% share of the venture. Other ITV broadcasters remained outside the ONdigital company. Carlton Communications Plc produced five channels for the original ONdigital, and three subscription channels for cable companies. At that time, its ITV franchises received a third of ITV's advertising revenue. It was also involved in program making, and the supply of products and services to the television, film and video industries worldwide. It owned, e.g., major suppliers of technical services such as Technicolor and Quantel, and distributed British television programs and films internationally. Carlton also produced over 1700 hours of television programs. Only one fifth of the programming hours were commissioned by ITV, and some of the most popular shows of the BBC and Channel 4 were made by Carlton. Mercury Asset Management Group and Lloyds TSB Group Plc were the major shareholders in the company (Carlton, 1998).

After original consortium was broken up, Granada sold its BSkyB assets. Granada owned shares in BSkyB because of the original satellite merger between British Satellite Broadcasting (BSB) and Sky Television, which had formed the company. Granada sold its shares to a French company, Vivendi in 1999, a deal seen as antagonistic by NewsCorp's Rupert Murdoch. The CEO of Vivendi, Jean-Marie Messier, had a hostile relationship with Rupert Murdoch, and they did not talk to each other for weeks after the deal (Chenoweth, 2002). Granada was the largest supplier of programming hours to the ITV networks. In addition to supplying programming and

television systems, it was also strongly involved with the travel industry. It began operating an ITV franchise in 1956, and in the late 1990's it held four franchises (CompetitionCommission, 1999). Granada and Carlton merged in 2004.

4.2.5 Telewest and Flextech

At the start of the study period, Telewest had the largest number of analogue cable customers in the UK. It only had franchises in the UK, but the owners included MediaOne International (30%) and TCL Communications (22%) (CompetitionCommission, 1999). At that time, TCL was also major shareholder in Flextech, one of the largest channel providers for different platforms (CompetitionCommission, 1999). Flextech and Telewest merged during the study period. Together, Flextech and BBC owned UKTV, a joint venture that supplied channels featuring BBC programming (CompetitionCommission, 1999).

4.2.6 NTL and Cable and Wireless

NTL has been strongly involved in activities outside of the UK and the cable business. The stock has been quoted on the NASDAQ exchange in the US. In addition to running cable franchises, its activities in the UK included broadcast infrastructure transmission services such as satellite uplink, radio and terrestrial television transmission (CompetitionCommission, 1999). In June 1998, Telewest Communications and NTL decided not to continue with merger talks. During the investigated time period in 1999, NTL bought the cable operations of Cable and Wireless Communications plc, making it the biggest cable operator.

After the study period in October 2005, NTL Incorporated and Telewest Global, Inc. announced a merger agreement under which NTL will acquire Telewest. The partners stated that the merger will create the second largest communications company in the United Kingdom with nearly 5 million residential customers (NTL, 2005).

4.3 Digital television evolution narrative 1998-2002

This section describes the competitive battle triggered by the transition from the analogue to digital television broadcasting business system in the United Kingdom

during 1998-2002. The emphasis of the narrative is on the television broadcasting and platform operating companies as they build the new digital pay television market and compete within it. Digital services in the UK were launched in 1998, and by 2002 the intensive competitive period was temporarily over, as all of the major commercial players except the winning BSkyB had gone into bankruptcy or debt reorganisation. The most visible competitive phases were launching, sponsoring digital boxes and content, and major restructure, and it is these phases which receive most of the attention in the narrative. These major incidents took place around smaller competitive bursts, which are described more briefly. Table 3 provides numerical statistics on UK digital television competition during 1998-2002.

Table 3. Evolution of digital broadcasting service providers' business from 1998 to 2002

	1998	1999	2000	2001	2002
BSkyB					
Subscribers ('000)	275	2100	4669	5496	6562
Revenue ('000 000 USD) ¹⁷	2377	2500	2798	3321	4174
Retained profit ('000 000 USD)	128	-539	-300	-776	-2079
ONdigital/ITV Digital					
Subscribers ('000)	110	552	878	1253	1207
Revenue ('000 000 USD) ¹⁸	0	34	162	253	183
Retained profit ('000 000 USD)	-51	-247	-434	-506	-602
NTL					
Subscribers ('000)			530	1253	1229
Revenue ('000 000 USD) ¹⁹	356	834	1518	2069	2074
Retained profit ('000 000 USD)	-534	-735	-2388	-11115	-2376
Telewest					
Subscribers ('000)		110	339	724	857
Revenue ('000 000 USD) ²⁰	335	417	423	474	505
Retained profit ('000 000 USD)	-517	-858	-1069	-2786	-3335
Freeview					
Viewer estimate ('000)					1450

¹⁷ BSkyB financial figures are on 12 months ending on July 31st of the reported year concerning group's activities. Pounds sterling exchange rate used here is the yearly average from Bank of England statistics downloaded from <http://www.bankofengland.co.uk/mfsd/rates>. Same rates were used for all other companies but NTL, which reports results in US dollars.

¹⁸ ONdigital / ITV Digital financial figures are on 12 months ending on Sept 30th of the reported year compiled from their parent companies (Granada, Carlton) annual reports concerning their respective shares of the joint venture's operations.

¹⁹ NTL financial figures are 12 months ending on Dec. 31st of the reported year concerning residential/local telecommunication and television units.

²⁰ Telewest financial figures are 12 months ending on Dec. 31st of the reported year concerning their cable television units.

4.3.1 Phase 1: Launch and competition of sponsored set-top boxes

The preparatory work on digital television in the United Kingdom focused originally on terrestrial delivery (Goodwin, 2005). The digital terrestrial television was seemingly in a position to leverage the wide penetration of its analogue programming. The interviewee 3 describes:

“All the attention was on DTT, the assumption was that DTT would drive digital [...inarticulate, not transcript] means of taking those households digital because rooftop area was what they were used to. Satellite was then a very much a minority platform, sort of add-on. Not any of public broadcasters were available on satellite. So, basically you added analogue satellite onto your terrestrial, it didn't replace it.”

The arrival of digital transmission seemed to favour terrestrial pay-TV and threaten the established analogue position of BSkyB satellite platform (Cool *et al.*, 2000). The exclusion of BSkyB from the terrestrial consortium was seen devastating for the media firm. In 25 June 1997, a column was written in Financial Times stating:

“This is not the end of BSkyB's dominance of UK pay television, but it is surely the beginning of the end. Slowly but surely, its grip on both distribution and content is relaxing. The era when the satellite group controlled access to most pay-TV eyeballs will soon be over” (Cool et al., 2000).

Despite described as an ‘add-on’ platform, BSkyB had by 1998 created an extensive analogue satellite customer base, and a market for pay-TV in the UK. The managers at BSkyB thought that their business model needed revitalising as problems were emerging. Penetration growth had stagnated, although the average return per household had been steadily increasing (Horsman, 1998). BSkyB chief executive Mark Booth saw that in the analogue era:

“We were a TV Sports company with some good TV skills, but we were not at the edge of what was happening in the multichannel world...we have to reinvent our content. We have to reposition ourselves with the consumers” (Horsman, 1998).

Elisabeth Murdoch, daughter of Rupert Murdoch, who had responsibility for improving Sky's own programming, offered the following characterisation in 1998:

"...we were leading [pay-TV market] with a stick rather than with a carrot...People say 'we don't trust Sky, and you treat us cynically, and you put the price up every single year' and you realise at some certain point that if you aren't putting the value back into your proposition, there is going to be switch-off" (Horsman, 1998).

Other motives for the launch of digital services came from investors. Enough investors wanted to see BSkyB as a first mover in offering digital television, and when rumours spread of possible delays because of satellite delivery problems, the stock price of the company fell (Horsman, 1998).

Digital television services started in the United Kingdom in October 1998 when BSkyB launched its Sky Digital satellite service. Satellite transmission technology provided BSkyB with advantages compared to analogue satellite, or terrestrial digital. Astra's satellite technology permitted BSkyB to start with broad coverage without extensive up-front investments. Thanks to improved channel carrying capacity, the new satellite platform could offer 140 satellite channels (Papathanassopoulos, 2002).

The British Broadcasting Corporation (BBC) wanted to have satellite access because of its stated policy of platform neutrality. However, access was settled only after difficult bargaining. BBC's digital channel offering was a subject of long negotiations and intense lobbying in the European Union and in the UK regulatory bodies. As a result of these, BSkyB had to give others access to the same satellite platform (Horsman, 1998). According to the interviewee 1:

"BSkyB didn't want us [BBC] on at the same time as them, because they didn't want to share the glory of launching digital satellite...And they played all kinds of silly games. And in the end we had to threaten to go to the regulator... As a result of the BBC lobbying supported by the British Government we got a clause in the access Directory, which required Sky to offer 'fair, reasonable and indiscriminatory access' through it STB. So we had a legal ground on which to fight. There was sort of balance of

carrot and stick. [A] threat [of] legal action and the carrot...Sky wanted the BBC there such that BBC launched its digital package at the same time as Sky's."

The negotiations offended traditional terrestrial broadcasters, as described by interviewee 1:

"And there was terrific internal schism about this because BBC and traditional broadcasters obviously ITV and Channel 4 as well had a duopolistic position in analogue broadcasting and introduction of digital would obviously undermine that position. So, there was very strong conservative force saying don't do anything to help it. Don't get in there and supply services, because you will increase the rate of take-up."

BSkyB made channel carriage agreements with the BBC and the two commercially funded channels, Channel 4 and 5, for its Astra satellite. Although the participants reported how difficult the negotiations were, it did not hinder B SkyB from leveraging the result; an improved channel offering on the satellite platform. BBC's and the other free-to-view channels on the satellite platform helped to legitimise its existence. B SkyB's satellite subscribers were now able to get highly appreciated public broadcasting services for free. Interviewee 3 describes:

"Sky naturally wants to give the impression that 'BBC brought to you by Sky', and you have to subscribe them together. They can't quite say that because that it is not true."

Despite the satellite platform being the first digital entrant, its emergence was somewhat surprising. Political and technological development had focused on the terrestrial platform. The emergence of competition through a terrestrial digital system (DTT) was driven by the British Government's White Paper of 1995 and the Broadcasting Act of 1996, which emphasised that viewers would get an improved variety of channels, programming, and new interactive services (Goodwin, 2005) through a competing terrestrial system. Due to technological constraints, terrestrial digital broadcasting could not deliver as much program content as its satellite competition. The first digital terrestrial television platform was launched one month

after BSkyB in November 1998 with an offering of 37 channels. The commercial pay-TV operator in the digital terrestrial television platform (DTT) was ONdigital (later renamed as ITV Digital), while the BBC, a local franchise of ITV, Channel 4, and Channel 5 were broadcasting independently on the same platform. By supplying highly valued content the latter were also lending their credibility to the platform.

While terrestrial and satellite were both offering highly valued free to view television, the comparison of pay-television offering was clearly in favour of satellite. From the beginning, conflict between the major operators was imminent. The initiators of terrestrial pay television interviewed in Horsman (1998) thought that DTT was a way of educating a mass of consumers about paying for the content, and the only way to do this was to have pay-TV without BSkyB and Rupert Murdoch (Horsman, 1998). Earlier, during the dominance of analogue television, terrestrial reception had been the predominant mode of getting the highest rated programming, while analogue satellite content had been seen as a minority platform; a supplement for movie or sports enthusiasts (Horsman, 1998). The terrestrial offer aimed to leverage the traditionally strong position of terrestrial programming already receivable with existing aerials. ONdigital compared the ease of aerials with the installation of satellite dishes (BDB, 1997), but their message was not entirely convincing. Low transmission power and low digital signal quality led to unreliable coverage and forced many customers to invest in their aerial systems in any case, negating the attractions of ON Digital's *'plug-and-play'* (DTG, 2001a, 2001e).

A third digital broadcasting service was launched in 1999 when Telewest launched its first digital cable service in their franchise. In May 2000 NTL, another major cable television company, introduced digital television services. The biggest digital cable operators were initially Telewest, NTL, and CWC, a subsidiary of Cable and Wireless. However, the cable business of Cable and Wireless was bought by NTL in 1999. The cable operators regarded it as important to consolidate the fragmented cable television industry.

The following passage from an industry journal clarifies these signs of the times:

“The news that General Cable preferred Telewest's offer of £649m to NTL's £550m came as no surprise. It seems like a lot of money for a

company which had not exactly been profitable in recent times, but it marks an important stage in the consolidation of the cable industry and places Telewest firmly as one of the big boys” (DTG, 1998b).

An interviewed expert (2) commented that consolidation advantages in cable marketing could have been achieved through alliances as well. Consolidation used up cable operators’ resources, and as result, their marketing and customer service were perceived as low quality. Interviewee 2 commented that:

“NTL is notorious for the quality--It has a reputation of having not good customer service and it manages to fail to meet even these low expectations.”

Price-cutting and free set-top boxes, sponsored by the competing digital service providers, were seen as a major driver for the fast development of the digital television business system in 1999 and 2000. The increase of new subscribers peaked in the latter half of 1999. Competition in the form of subsidies played down the significance of switching costs and technological lock-in associated with potential positive feedback dynamisms. Since all of the competing digital television broadcasters were providing free set-top-boxes, the imitation of strategy failed to make a difference, but caused significant financial pressures for the financially weaker competing firms. An interviewee (4) described the dynamics in hindsight:

“ITVdigital had been forced, or felt they were forced by Sky to give out receivers, and the whole act subsidising, giving out receivers, was a big financial burden. -- That was one milestone, the day Sky decided to give away STBs, the rules were changed, because ITV Digital/ONdigital decided they have to act upon it.”

In addition, interviewee 2 questioned the necessity of ONdigital’s imitative strategies:

“I think they [ONdigital] felt they were forced to compete when Sky was giving the services. And, they felt they were forced to do it. I am not convinced that they had to. But, they felt they had to.”

Interviewee 3 shared this view:

“In 4-5 months after their launch, Sky was announcing, that they are going to give free boxes. They [ONdigital] had to match. Now, the reason they had to match was because they had locked-in to this strategy that they must compete with Sky. ---This was the decision made in spring 1999 and it completely changed the market. It also meant that ITV was dead. It would take them three years to die, but that was it!”

4.3.2 Phase 2: Competition over content

There was a switch in emphasis from set-top box sponsorship to content competition. The major phases were overlapping in their timing, because competition in the form of programming had already started at the launch of digital television, and is still going on. The change in emphasis in the second phase of business system evolution can be seen in the relative costs of programming. The latter paragraphs will show how the programming content became very costly. Exclusive and even discriminatory content supply arrangements took place in this arena of intensified competition.

There was a market for pay-TV, and different studies showed that customers were willing to pay for the premium content (CompetitionCommission, 1999; ATV, 2001). Most potential adopters of digital television (especially prior to the Freeview service in 2002) were offered a pay service package with additional free-to-view services. The pricing of the package is such that the marginal cost of adding a new channel declines. Premium pay services include more expensive channels featuring sports and movies. Pay per view is a service for films and events programming (Bajon & Fontaine, 2001). The ability to provide the most popular, traditional television channels with an emphasis on sports and movies was important for the early digital television adopters (Consumers'Association, 2001; Theodoropoulou, 2003). This may be related to the fact that early adopter households were more likely to have young male members or children, compared to non-digital households (MORI, 2001). In a survey carried out in 2000, seven out of ten BSkyB customers felt that channel variety was the main reason for their choice of service provider (Theodoropoulou, 2003).

Granada and Carlton were the owners of ONdigital, and the most important franchise holders in the national Independent Television broadcaster network (ITV). Granada and Carlton saw that platform competition was more important than channel

competition, the latter being an arena in which they were familiar. In order to help the competitiveness of the terrestrial platform, they also refrained from supplying the ITV channels to BSkyB's satellite platform. Before the commercial launch, BSkyB Chief Executive Mark Booth accused ITV of

*"...withholding its channels (from Sky Digital platform) for private gain"
(DTG, 1998a).*

ONdigital showed BSkyB programming, but remained hesitant to supply its own channels to the satellite platform. Interviewee 4 described the arena of competition:

"Therefore they went to pay-TV in a big way, half of the digital terrestrial capacity. They were in the business of packaging of programs, ITVdigital, or ONdigital, as it was then called. They didn't package BBC's programs, but ITV's programs and other channels that they bought in and included in their three spare multiplexes. They took the view that satellite, and cable for that matter, were rivals, in the pay-TV world, and as a result they didn't acquire satellite capacity or seek satellite distribution until very near the time of their collapse. They were engaged in platform war, head-to-head competition, whereas the BBC was not. That is a very big difference."

Both commercial terrestrial platform owner companies had traditionally supplied highly rated television series for different channels distributed by other broadcasters. The original intent expressed was that the platform would build on the programming talent and resources of parent companies with some BSkyB premium content. The idea of own content is evident both in the tender documents for the DTT license and the first channel offering of ONdigital (BDB, 1997). The initial confidence in their pay-TV platform eroded, as ONdigital was not able to build on the appeal of its owners' channels. In coming years, ONdigital discontinued many of its own channels, and acquired some of the popular BSkyB channels instead. Interviewee 3 did not see original content as a distinctive competitive advantage, however. The interviewee stresses that the channels offered by the owner companies had not been an appealing proposition for customers. The interviewee also raised the issue of imitation of BSkyB strategies, now regarding the composition of channels:

“Their normal business decisions were distorted by their shareholders’ desires to push their channels. They also had the crazy notion that they could compete with satellite. This meant for them they had to have all the premium channels which satellite has. Which is a problem, because they are all Sky Premium channels. So, they were in the unfortunate position that their biggest competitor, as they saw it was their supplier of the channels they thought they had to have in order to compete. Very tricky position, indeed!”

When ONdigital gave up the opportunity to differentiate with its content, they faced at least three problems. Firstly, ONdigital gave up some of the channels of its parent companies, which would have helped the owners. Secondly, when ONdigital chose to offer the channels of its main rival, this led to a less differentiated proposition for the viewers. Third, the terms that BSkyB offered for the supply of BSkyB’s own channels to the other platforms were highly unfavourable for competitors. The Chief Executive of ONdigital/ITV Digital, Stuart Prebble, commented on the situation later in 2003:

“Sky charged ONdigital a higher wholesale price than the retail price it charged its own customers” (Goodwin, 2005).

Regulators investigated and later also found evidence that BSkyB really had acted anti-competitively and abused its competitive position as a provider of premium sports and film channels to rivals ITV Digital, NTL, and Telewest (OFT, 2001; ATV, 2002). Despite some evidence, there were insufficient grounds for judging that the firm had violated its positions as a dominant content provider (OFT, 2002).

BSkyB chose to pioneer premium digital pay-TV content, specifically sports. Despite the supply agreements between BSkyB and its reseller, BSkyB was losing money, partially because of the increasing prices of programming rights. Already before the digital era, football came to form a cornerstone of BSkyB’s offering. One interviewee (1) commented on the competition for sports content:

“Our [BBC] business analysts modelled what Sky could offer for football in 96-97, and we came to conclusion that it was make or break in their

business plan. They had to have Premier League, and therefore they were ready to bid what ever it took”.

Sports programming was a major arena of disagreements. ONdigital accused BSkyB of failing to honour its contract to supply Sky Sports 2 on the terrestrial system (DTG, 1999b). At the same time, the demand for content increased the prices for sports rights, and media companies even started to buy soccer teams. BSkyB paid £1.1 billion (approximately US \$ 1.5 billion) in 2000 for a 3-year contract to show live English Premier League soccer games. Former BBC Director General Greg Dyke described the reasoning for pay television’s enormous interest in sporting rights:

*“Millions of people in Britain pay BSkyB £40 a month just to get their football; the advertising revenue involve is worth nothing like that”
(Dyke, 2004).*

BSkyB could transmit the price to the customers, but only partially. BSkyB’s viewers paid, on average, higher revenues per household compared to competition because of a wider variety of services and more expensive top-tier packages. According to interviewees however, the premium channels were not as profitable for BSkyB as the basic channel package. The emphasis on providing premium channels was due to ‘industry obsession’. Imitation was also visible in competitors’ adoption of BSkyB’s channel bundle structure, as well as in the pricing adopted for the channel bundles. Interviewee 2 commented:

“The way they [the channels] are bundled is much more similar [than the channels themselves], and it is interesting to speculate about whether that is because consumers compare between them and they want the same things with the same money, or whether it is because Sky has such control of the way the channels are sold. I think it is for both. Partly because Sky is doing it, others have to do it. And partly, because it has control over certain key rights.”

The quote above emphasises how the competitors chose a particular way to compete favouring one of them. The ‘key rights’ the interviewee mentions refer to the popular content that BSkyB was offering on its channels. But, as mentioned elsewhere, the

success was not only a result of their perceived quality, and also related to the supply decisions of the challenger firms.

The BSkyB was also successful when measured by churn. Customers tended to shop for bargains, but to stick with the highest perceived value offerings. The subscriber data shows that customers returned their equipment in great numbers after the subsidy periods ended, and switched back to their preferred systems (DTG, 2001a). The yearly rate of churn in terrestrial and cable companies was 20-29 percent (DTG, 2000d, 2000e, 2000c). The result announcements reveal how BSkyB's churn constantly remained significantly smaller than its competitors'. The ability to have lower churn had a significant positive impact on BSkyB's profitability. ITV Digital interpreted that the rate of churn correlated with the stage of growth (DTG, 2001g). In its analysis, it reasoned that the size of customer base brings stability, implying a need for fast growth.

BSkyB wanted also other content providers to leverage the carrying capacity of satellite. Interviewee 3 described how BSkyB developed its network of offerings:

“They took the advantage of economics of digital to encourage third-party channels to really make use of it. The Discovery channel, for example, started off as one channel in analogue and in digital it made like 10 channels. They really encouraged that...”

The variety of BSkyB's channel offering is seen already in the first years of digitalisation, which is visible in e.g. Figure 8 Digital television business system 1999. In addition to widely known channels, the large network provided minority taste channels including Asian services. These provided BSkyB with a chance to tap into many sub-markets. Also a high value in Bonacich power centrality describes the important position of BSkyB among different firms.

The major content supplier outside of the camps of major platform providers was the BBC; it having a policy of platform neutrality. It wanted its channels to be delivered through every platform, although this added an extra burden to its license fee funding. The corporation also developed services that leveraged new digital possibilities. In 2001, the BBC introduced multi-channel programming in its traditional coverage of

the Wimbledon tennis tournament. The viewers could choose the match they wanted to see from a selection of five courts. The BBC offered the service on satellite and cable platforms, which could provide the necessary technology. ITV companies argued that the Corporation were wasting tax-payers money as they provided a new kind of service to two of the three platforms (DTG, 2001c, 2001f). The Culture Secretary (Department of Culture, Media and Sport), Mr Chris Smith evaluated the role of the BBC as follows:

"As our principal public service broadcaster, the BBC should continue to set a benchmark for the industry as a whole..." (DTG, 1999c).

The ITV group had been restrictive in not delivering its premium channels on cable and satellite, especially to BSkyB in order to support its own ONdigital/ITV Digital pay-TV platform. The disagreements over the delivery of ITV channels changed during the years, as it became more obvious for the ITV network and its related firms to be on satellite. The tone in discussions started to involve how much the ITV network had to pay BSkyB for conditional access (CA) in order to get their free-to-view channels regionally distributed on their the popular satellite platform. The digital platform insisted that all the other firms had to pay for their access, even the public broadcasters. Before the firms settled, Chris Bryant, a member of the parliamentary committee, called for intervention to ensure that ITV programming would be seen on the satellite platform. The following excerpt describes his position:

"Sky homes can't get ITV 1 unless they switch off the satellite receiver. That's wrong, I want everyone to be able to get ITV 1. If Sky and ITV can't agree a sensible price by the end of the month then Oftel should intervene to make sure that Sky viewers don't miss out." (DTG, 2001d).

In their marketing effort, ONdigital was re-branded as ITV Digital in 2001. While the platform firms were negotiating on the terms of access of free-to-view channels, the premium channels of pay-television were a related area of competition. The launch of a new subscription service, ITV Sport, with a budget of £150 million, was made available to subscribers of terrestrial ITV Digital and cable company NTL. Following BSkyB's example in their effort to show highly valued football, ONdigital bought the rights for the second-tier Nationwide League sports channel for nearly £315 million

(approximately US \$454 million). The CEO of ITV Digital, Stuart Prebble, explained that the high price was justified for on competitive reasons. ITV Digital intended to wholesale the channel to BSkyB. The venture would have been proven profitable if ITV Digital's strongest competitor would have delivered their network's premium channel. But, the executives BSkyB did not want to include ITV Sports in their package (Goodwin, 2005). The justification stated by Mr. Prebble was highly questionable, considering the competitive record of BSkyB and Mr. Murdoch and his enterprises. With hindsight, the personal and company experiences could have predicted what the BSkyB's responses were, but the interviewees point to another motivational factor. The perceptions about the market and competitors were not giving advice for how managers should avoid head-on battle with serious consequences. On the opposite, the mindset was constraining managers' behaviour. An interviewee (3) commented on the imitative battle:

“They had gone into this position, this mindset that we [ITV Digital] had to compete-- that means we must have everything they've got and then we must have something else as well on very limited bandwidth and without the money News Corporation [BSkyB parent] has.”

An evaluation by interviewee 2 echoes the previous statement. The competition was played under rules that were not suitable for everyone:

“They [ITV Digital] were kind of me-too, kind of forced to play Sky's game and they couldn't as well as Sky could.”

Interviewee 1 suggests causality from motivational aspects to the end result:

“ITV got emotionally engaged in the bidding process -- when they lost [Premiership] they were prepared to pay over the odds for second-rate package. And that's what destroyed ONdigital.”

Emotions and imitation were seen also with BSkyB's action. Interviewee 3 described the end result of series of competitive actions:

“When I talked with Sky people when I was [describing interviewees previous position] I said, ‘why are you obsessed with these people? They

will compete with you at the margin, only. The vast majority of potential adopters are satellite. They will never going to be interested on taking this offering.’ ”

The quote above emphasises that imitative competition took place, even when it was not profitable to anyone. The interviewee quoted above saw that BSkyB was following similar pattern to that of ITV digital, and made unnecessary losses for the sake of destroying a competitor.

Cable television companies had enjoyed wide pay-TV customer base already in analogue technology, which eased the possibilities for customers to adopt their new technology (Papathanassopoulos, 2002). After a major consolidation of the cable television industry, still slowed down by their financial problems, both Telewest and NTL saw the opportunity to leverage their cable customers more efficiently (DTG, 2000a). The companies remained confident that they would soon overtake satellite in popularity (DTG, 1999c, 2000f; DTG). The technological advancements in the history of British cable suggested a business commentator to describe the U.K. cable industry as ‘Rolls-Royce of cable systems’ (Spar & Zakaria, 1998). Mr. Barclay Knapp, the Chief Executive of NTL, evaluated the situation:

"I hope people realise that cable will have a competitive advantage. Our network has a superior capacity and reliability than any other in the country. Sky will reach its target of 7 million customers, but cable should pass 12 million in the next few years." (DTG, 2000a).

Cable companies could strengthen their own value networks. Due to technological reasons there were some complementary services that were first introduced in cable, e.g., an interactive trading service (DTG, 2000b). The companies also introduced a telephony and internet service alongside the television offering, and sold this as a bundle. This ‘triple play’ was an original advantage of cable firms, but the effect was reduced by the actions of satellite and terrestrial competitors. BSkyB and ONDigital offered internet services and telephone calls using other providers. These included firms that were not as active in other aspects of competition, e.g., telecom firms such as the former monopoly BT, and the technologically advanced Kingston Communications.

The terrestrial platform was at a disadvantage because it could not provide as many services. It took some time to solve the technical problems in order to offer some of these services. ONdigital/ITV Digital tried to manage positive expectations with far-reaching announcements and trying to compare itself advantageously with its competitors. According to the Chief Executive, Stuart Prebble:

"ONdigital will offer [mostly in year 2000-2001, added by A.S.] a wide range of interactive services to its subscribers. Unlike satellite,..." (DTG, 1999a).

The comment above shows the antagonism typical in the researched period. A firm is solving a problem it is facing, and the equation involves the competitor in one form or another.

4.3.3 Phase 3: Shake-up and re-organisation from 2002 onwards

The financial figures of BSkyB in Table 3 show that, despite its lead, the company was a losing operation. Despite strong and improving revenues, the free cash flow remained negative in the financial year 2002 ending 31 July (BSkyB, 2002).

For strong growth orientated, network-dependant companies, active networking benefits a company as long as there were positive expectations. However, the network also transmits problems when they occur. Due to resource-consuming acquisitions among the cable operators, and extensive investments in the digital broadcasting business, both NTL and Telewest had to make debt-for-equity arrangements and their chief executives were ousted from their posts. The most active manufacturing company, the UK-based set-top box manufacturer Pace, suffered from the financial difficulties of NTL. The problems were transmitted from the buyer (NTL) to the supplier (Pace) by insurance companies, which did not want to give more credit to the indebted operator (Sabbagh, 2002). CEO Malcolm Miller had earlier been praised for his leadership but now was forced to leave office. The Financial Times commented on his departure:

"He is credited with having propelled Pace into a market leading position by keeping investment in research and development high, while minimising manufacturing costs. But some shareholders said he had

failed to spot early signs of the market's deterioration this year and badly managed the company's ensuing string of profit warnings...One shareholder said: 'He had lost credibility following his misguided optimism'“(DTG, 2002b).

Funding shortages and debt problems ended ITV Digital’s terrestrial operations on May 2002 (Marshall, 2002). The network had already shrunk before its closure. Its £315 million (approximately US \$ 454 million) contract for the Nationwide League rights was the final blow to a company that had already used up its financial resources for hardware subsidies and building up its network. The manager who led the BBC at the time summarised the events:

“ITV Digital was a broadcast platform with substandard technology, a consumer proposition with little appeal and a business model that failed to account for a strong competitive market” (Dyke & Abery, 2002).

A four-year football deal was later signed that transferred the rights of the Nationwide League to BSkyB for only £95 million (approximately US \$143 million). As ITV Digital had also acquired content from its platform competitors, the collapse initially worsened their financial situation because ITV Digital did not make payments according to contracts. The digital service providers were only able to pass more of the costs to the end-customers after the first exit. The relieved pressure on competition in the consumer markets were seen in financial statements, though with some delay. The annual report for 2002 of BSkyB, ending in July included losses due to the ITV Digital’s inability to serve its debts. BSkyB lost a competitor, but also a major customer. The change in the business environment was more visible in the first half results of 2003²¹. The number of subscribers continued to grow, while marketing expenses declined. The press release accompanying the interim report stated:

“The Group has marked its return to profitability by delivering a profit after tax of £16 million for the period, resulting in earnings per share of 0.8 pence compared to a loss per share of 71.8 pence for the comparable period. This is the first time the Group has delivered positive earnings per share since the launch of the free set top box offer in May 1999, which

²¹ 1 H 2003 ended 31 December 2002

resulted in a period of heavy investment in subscriber acquisition”
(BSkyB, 2003b).

The annual report for 2003 report ending 31 July 2003 restated the reversal, offering bigger numbers:

“Profit after tax was £190 million, the Group’s first full year of positive earnings since the launch of Sky digital” (BSkyB, 2003a).

Interviewee 3 described the shake-up:

‘The shareholders of Sky got no dividends for year after year after year. They were always promised, it would come...For broadcasters the situation has changed, ...Sky has [been] going around broadcasters these couple of years when their contracts come to renewal and say, “We’ll pay lot less”. And all of them have agreed to get less.

The interviewee 3 had similar view:

”In the long run, the big winners are Sky’s shareholders who finally gained dividends -- they could finally see real money, because Sky took the accounting decision early on to write-off all the costs of a [set-top] box giveaway--So, huge losses initially. But, now they are in a great position, it is all cash. So Sky is a huge winner in the long run, they gambled, they came good for them.”

The new competitive setting affected firms who had less to bargain with. Entrants new to television industry had often to choose a partner, and the options were now reduced. BSkyB’s leading position in the business system is seen in the comment of Michael Loeb, the Chief Executive of TotoPools, when he announced a partnership with BSkyB:

”Access to Sky Digital’s nationwide television audience will allow our brand to penetrate an entirely new audience of potential players” (DTG, 2002a).

Betting has so far been the single most important interactive pay-service, as 80% of interactive revenues came from betting (DTG, 2001b, 2002c), and several sports entertainment partners, including technology partners, joined the television value chain.

By 2002, the bidding wars had eased and terms of contract started to reflect the new competitive situation. Complementary products were now supplied on BSkyB's terms. An interviewee 1 commented:

“This is a game of such high cost that only the big boys can play. It’s obviously good for the multiplication of independent producers because very much more material was needed because channels multiplied. But, the kind of budgets that were used were getting lower and lower. So, it was sweated labour for indies [independent television production sector].”

The successor of ITV Digital, re-named Freeview, was launched in October 2002, backed principally by BBC, multiplex operator Crown Castle (formerly BBC's transmission division) and by BSkyB. In the multiplex application, the consortium behind the new venture expressed its deviation from the imitative strategies of its predecessor (Dyke & Abery, 2002).

Freeview was operating a free-to-view model with channels paid for by license fees and advertisements, and was therefore radically different from the pay-TV model. The new role in the consortium suited the BBC well because it had extensive financial resources and it had been active almost everywhere else in the business system from the beginning of the diffusion of digital service.

The owners of ITV Digital, Carlton Communications plc and Granada plc, announced an agreed merger on October 2002, a deal that came under competitive scrutiny, and was approved in 2004 (CompetitionCommission, 2003). The plan proposed a fully consolidated ITV that would be one of the leading commercial broadcasters in Europe.

4.4 Social network analysis of the industry evolution

Social network analysis was conducted to investigate how the relationships and positions evolved during the study period. The networks visible in the charts of this chapter include both published channel listings and firm co-operation arrangements. The difference in these two categories is visible in the charts.

Social network analysis provides centrality measures that describe the position of firms in the market, with implications for performance (see e.g. Powell et al., 1996). Following the centrality scores and different ranks for each separate year, centrality offers a longitudinal view on individual firms and on the market. As the data includes different kind of relations, an evaluation between different types of firms is not possible. For example, a manufacturer cannot have direct access to many channels, which have the most significant impact on the social network measures.

The digital television business system structure at the end of 1998 (after the two first commercial platform provider's digital entries) is visualised in Figure 7. For the first nine months, competition for new customers was quite even between BSkyB and ONdigital (Goodwin, 2005). The difference between the platforms is visible, but not as stark as it was to become.

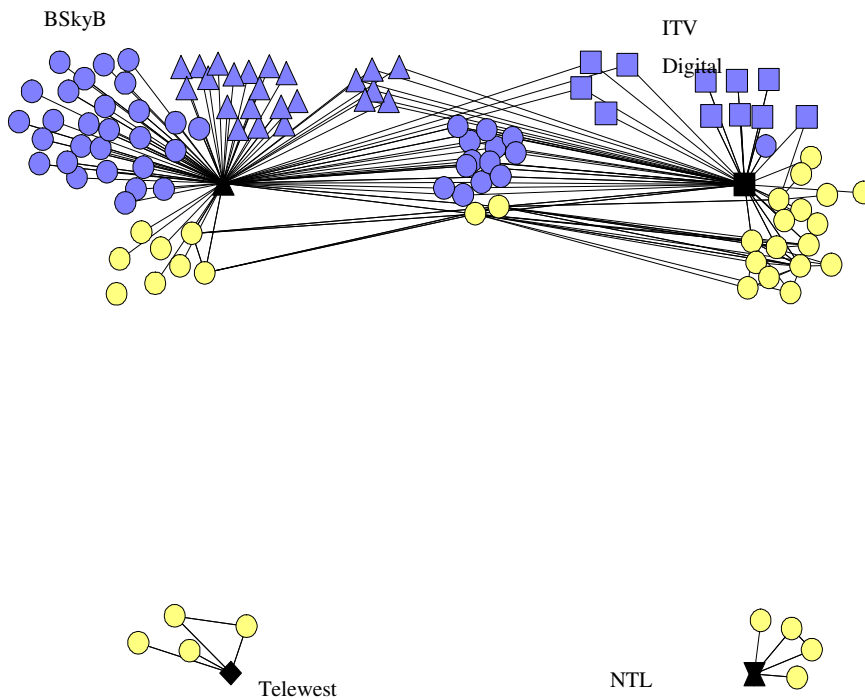


Figure 7 Digital television business system 1998

Legends: Co-operative ties are marked with lines. The major pay-TV platform service providers are coloured black, channels mentioned on listings are coloured dark, and co-operation arrangements with other firms are coloured light. BSkyB affiliated operations are marked with triangle, ONdigital/ITV digital with square, NTL with hourglass symbol, and Telewest with diamond symbol, respectively.

The race for a dominant digital platform entered a new phase when extensive hardware technology sponsorship came into play. The supplier and partner networks of NTL and Telewest were initially isolated, reflecting the fact that it took time before they were able to get their digital television offerings in place. The corresponding business system structure at the end of 1999, after the cable operator Telewest also entered the digital market, is shown in Figure 8.

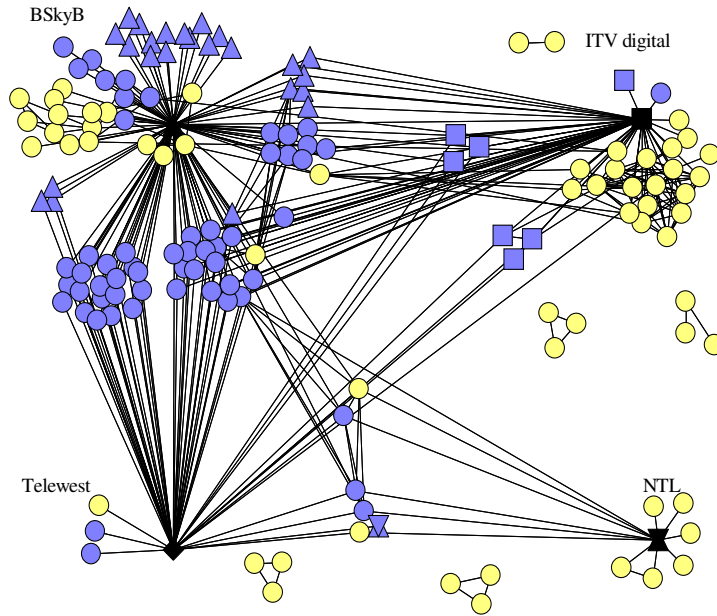


Figure 8 Digital television business system 1999

Legends: Co-operative ties are marked with lines. The major pay-TV platform service providers are coloured black, channels mentioned on listings are dark coloured, and co-operation arrangements with other firms are light coloured. BSKyB affiliated operations are marked with a triangle, ONdigital/ITV digital with a square, NTL with an hourglass symbol, and Telewest with a diamond symbol, respectively.

As markets started to mature and new entrants emerged, BSKyB's development was slower than its competitors. In Bonacich power terms, the lead of BSKyB was clear, but the challenger firms were closer in relative terms in 2000. The other platforms increasingly shared the same channels, linking the competitors more closely to the industry leader.

In the middle of the graphs emerges a group of channels shared by every platform, or by three out of four. The cable platforms' unique channel offering and partnership network seemed to erode between 2000 and 2001 in favour of shared assets. As ON Digital's resources were limited, it started in 2000-2001 to slide to a more isolated network position. The change is seen by comparing the figures in Table 4, which includes information on the exclusive channels of the platforms.

Whilst BBC-branded television channels were the most visible signs of the Corporation's presence, it was also strongly involved in the development of digital technology standards and applications. The BBC's strategy led to a situation where it became increasingly central over time in the industry network, measured in terms of Bonacich power centrality measures.

A visual inspection of Figure 9 and Figure 10 further shows BSkyB's central role. The improvement in the digital cable offer is also clearly visible.

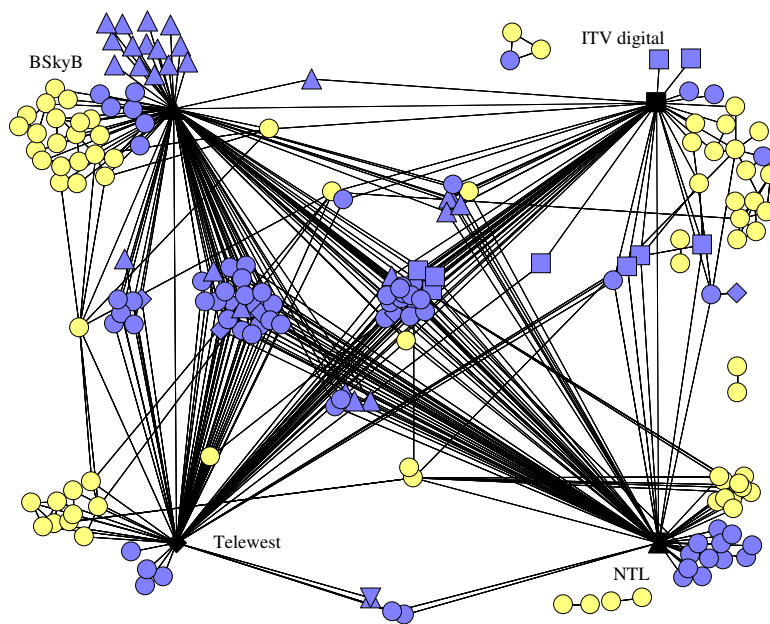


Figure 9 Digital television business system 2000

Legends: Co-operative ties are marked with lines. The major pay-TV platform service providers are coloured black, channels mentioned on listings are dark coloured, and co-operation arrangements with other firms are light coloured. BSkyB affiliated operations are marked with a triangle, ONdigital/ITV digital with a square, NTL with an hourglass symbol, and Telewest with a diamond symbol, respectively.

Some of the complementors entered the industry with new kinds of services. There was pressure on some other firms or operations providing complementary services to secure their positions by having ties with several major actors, but the entrants did not act in a uniform manner. Some of them were closely linked to a core platform, while others entered the market without strong partners. The latter group has poorer visibility in the eyes of the media, and therefore, their activity could have been

stronger than the media recorded. The evolution can be seen in Figure 9, where denser connections are observable. There was also a pattern of complementary entries in the television case. New interactive services joined the value system later than manufacturers, and they never had a central position in the network.

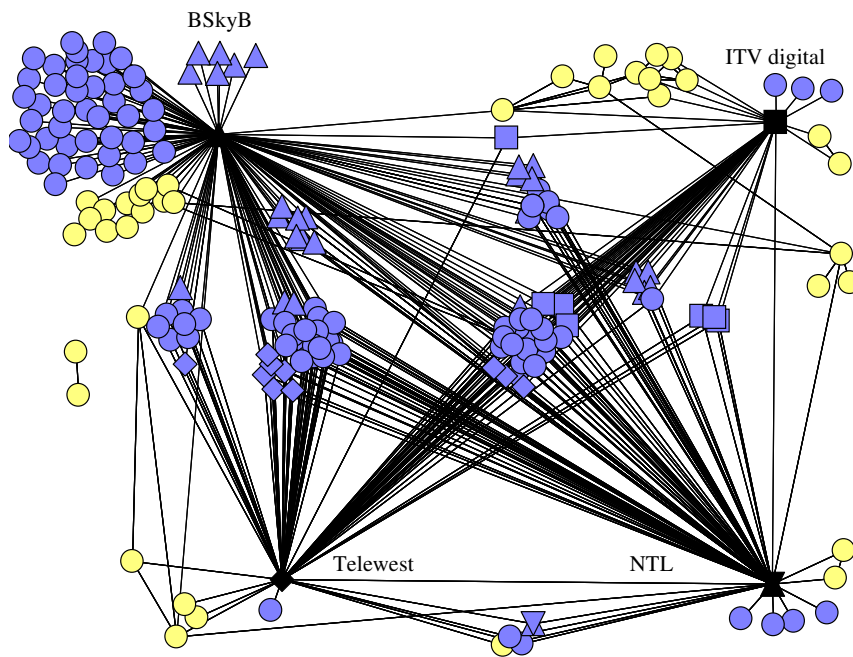


Figure 10 Digital television business system 2001

Legends: Co-operative ties are marked with lines. The major pay-TV platform service providers are coloured black, channels mentioned on listings are coloured dark, and co-operation arrangements with other firms are coloured light. BSKyB affiliated operations are marked with a triangle, ONdigital/ITV digital with a square, NTL with an hourglass symbol, and Telewest with a diamond symbol, respectively.

The collapse of ITV Digital also gave more room for cable companies, and their revenues and subscriber figures started growing again. As NTL managed to organise its debt structure earlier, it also started improving its channel line-up before Telewest. Figure 11 shows that NTL especially started investing in its digital offering despite its

financial constraints. The new Freeview platform relied heavily on content shared by others, operating on a free-to-view model. The new role of the BBC in the Freeview consortium strengthened its role in the industry networks. As the BBC, with BSkyB and Crown Castle, were the leaders of the consortium, the positions of these companies became more central and similar in social network terms. The BBC's power was second to commercial platforms. Despite their extensive co-operation with BSkyB, the companies were involved in disagreements on, for example, channel carriage costs. They did not, however, become direct competitors in commercial markets, as the BBC primarily remained a non-profit, public service organisation.

Table 4 Network position of major U.K. digital television firms²²

	1998	1999	2000	2001	2002
BSkyB					
Exclusive digital TV channels	45	18	18	43	65
Exclusive channels/ all TV channels	68%	23%	23%	33%	36%
Bonacich power centrality/ rank in centrality	56.5 / 1	70.5/ 1	75.3 / 1	116 / 1	150 / 1
ONdigital/ITV Digital					
Exclusive digital TV channels	9	2	2	2	2
Exclusive channels/ all TV channels, %	30%	7%	6%	6%	6%
Bonacich power centrality/ rank in centrality	29.3 / 2	35.8 / 3	35.5 / 4	33.8 / 4	27.3 / 4
NTL					
Exclusive digital TV channels			11	4	5
Exclusive channels/ all TV channels, %			16%	5%	5%
Bonacich power centrality/ rank in centrality	3 / 24	8 / 4	60.3 / 2	69.8 / 2	91.8/ 2
Telewest					
Exclusive digital TV channels		7	4	2	4
Exclusive channels/ all TV channels, %		14%	57%	3%	5%
Bonacich power centrality/ rank in centrality	3.7 / 20	41 / 2	54.3 / 3	57.8 / 3	78.8 / 3
Freeview					
Exclusive digital TV channels					2
Exclusive channels/ all TV channels, %					5%
Bonacich power centrality/ rank in centrality					24.5 / 5
BBC					
Bonacich power centrality/ rank in centrality	4.8/10	0.5/149	9.0/6	4.0/6	22.5/6

Table 4 illustrates how, in Bonacich power centrality terms, BSkyB led the market, as it was ranked first in centrality throughout the investigated period. The Bonacich score continued to increase implying that the leader remained the focus of industry

²² Bonacich power centrality is calculated using attenuation factor 0.0

evolution. The Bonacich power is not a relative term, so the score has the ability to increase or decrease for all of the participants in the given period.

The Bonacich centrality formula can possibly tell more about the structure of U.K. television. Bonacich centrality can be interpreted as a measure of imitative behaviour among challenger firms. A rising Bonacich centrality among challengers is a sign of congruence, while a decrease would signal isolation. The challengers received a bigger share of BSkyB's power, as they shared more of the same channels. The rising Bonacich centrality for them was at the same time a loss of distinctiveness in terms of channels and alliances.

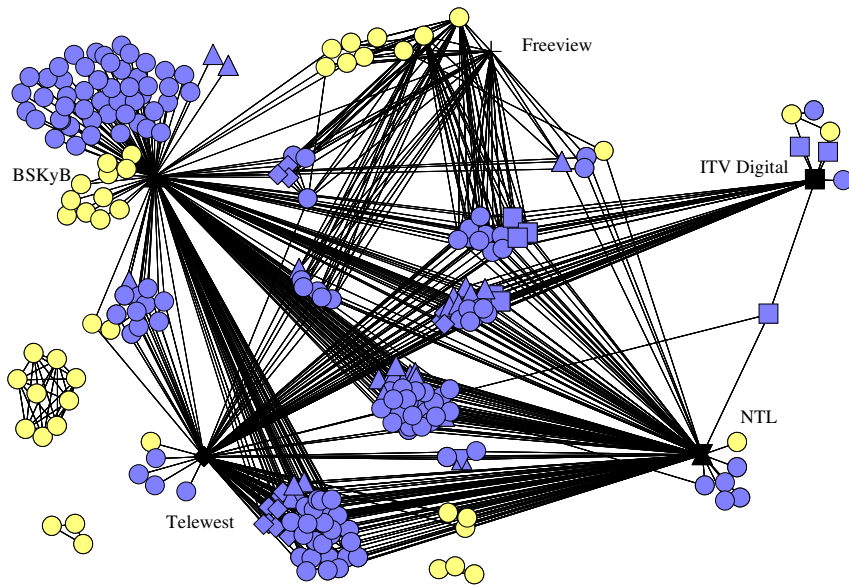


Figure 11 Digital television business system 2002

Legends: Co-operative ties are marked with lines. The major pay-TV platform service providers are coloured black, channels mentioned on listings are dark coloured, and co-operation arrangements with other firms are light coloured. BSKyB affiliated operations are marked with a triangle, ONdigital/ITV digital with a square, NTL with an hourglass symbol, and Telewest with a diamond symbol, respectively.

4.5 Public statements portraying managerial mindsets to competition and markets

The digital television narrative contained several examples of firms competing at the expense of profitability. There were several potential motivations for such behaviour. Competitive behaviour can also be evaluated by looking at series of actions which have the potential to disrupt the competitive status quo (Ferrier *et al.*, 1999). The phenomenon of competitive ‘wars’ have received limited research attention, and especially the role of language during intensified rivalry (Rindova *et al.*, 2004).

By looking at what people said at the time of competition, one can observe imitative or divergent directions of the industry. Theoretical concepts have stressed different aspects of positive and negative feedback (e.g. Arthur, 1990; Das & Van de Ven, 2000; Dickson *et al.*, 2001; Noda & Collis, 2001; Lee & O'Connor, 2003; Ehrhardt, 2004; Suarez, 2004). A common theme is that positive feedback mechanisms and local learning increase firm divergence. Convergence is a product of global learning and strategic imitation (Noda & Collis, 2001) and is related to negative feedback.

4.5.1 Statements expressing positive or negative feedback

In addition to the case narrative and the network analysis, I also performed a content analysis of the quotations found from published news stories or company announcements. Content analysis was made on quotations, or statements of actual persons involved in evolution, published close to their first occurrence. Ferrier (1999; 2001) divided actions into six categories, of which I used only signalling. My aim was to capture only the signalling action events in the process of competitive interaction (Ferrier *et al.*, 1999; Ferrier, 2001). The reasons for selecting only one action type are three-fold. First and most importantly, most of the actions can be understood as signalling, because they have usually been announced or leaked to the media intentionally. Second, due to the relatively small amount of data and diverse evaluations by the reporting news journalists, a coarse-grained categorisation was a more reliable method. Third, my approach is along the lines of suggestions set by Rindova *et al.* (2004). The article called for competitive action researchers to go beyond competitive attacks, and to analyse the strategic themes in patterns of

competitive interaction by attending to the language games being played (Rindova et al., 2004). The importance of 'war language' (Rindova et al., 2004) emphasises the visibility of actions, compared to the specific material nature of the action.

The firms involved were digital service broadcasting companies during the period 1998-2002. The 462 statements were classified under two nominal variables (Krippendorff, 1980). The statements were classified based on the attitude to growth and competition, reflecting a reliance on positive or negative feedback using two nominal categories. To be valued, an announcement, or a reported quote has to possess clear implications for an announcer's attitude to categories. The positive category included statements implying firm's progressive or above-average growth strategies, own initiatives, leveraging the network for further growth, and confidence building measures, which are signs of trust in the favourable outcome of positive feedback mechanisms. The negative category included quotes on policies aimed at efficiency, firm's actions to leverage the network for cost-savings or imitation, or claims of the hostile behaviour of competitors. These include the use of military language (Rindova et al., 2004), but also non-military expressions. The above examples of negative feedback comments stressed market share irrespective of the market size. Competitive bidding, or sponsoring to acquire valuable assets, belonged to the negative category as signs of imitative behaviour. These comments reflect the idea that the well being of the commentator's firm does not require a joint institutional setting.

The statements were classified as 313 quotes reflecting a focus only on positive feedback dynamism, and 107 quotes reflecting a focus on imitative, cost-cutting policies, characteristic of negative feedback dynamism. Some quotes (42) expressed both feedback types. This implies that in 355 quotes there were positive feedback expressions, while in 149 there were negative expressions.

Negative feedback comments were less frequent, which should be reflected to the fact that the technology and market were still being created, so there was less incentive for exploitative strategies and cost cutting. In a growing market, the emphasis was on building trust, or even 'hype' among the customers. In this context, negative comments had the potential effect of derailing not only competitors, but also the

introduction of the technology. I observed positive comments as expected, and there was not a significant variance in statistical terms between the firms.

At a time of the introduction of a new technology, critical comments do not support market creation, and so their occurrence requires more careful investigation. As could be expected based on the case narrative, the challengers and their parent organisations, including the BBC, expressed their views with a negative feedback mindset more often than BSkyB .

There was a significant difference in negative comments between the groups. The difference between BSkyB and its challengers, namely ONdigital/ITV digital with their parent organizations, Telewest, NTL, and BBC, is also observable in cross-tabulations. In Table 5, expressions about the negative feedback loop are cross-tabulated with the respective firm sending out the statement. SPSS software was used to produce the tabulations and tests.

Table 5 Firm and negative feedback cross-tabulation²³

Firm	Negative feedback expressions	No negative feedback in expressions	Total
BSkyB	13	42	55
'Challengers'	63	79	142
Others	73	192	265
Total	149	313	462

The results imply that the relationship between the type of firm and expressions of negative feedback is statistically significant in the case database. A binomial investigation is coherent with the earlier investigation and supports the above conclusion that the 'Challengers' expressed negative feedback significantly more fiercely than other firms did. In a binomial investigation, percentages of negative expressions are evaluated according to the average number of negative quotes in the sample. The average of negative feedback loop expressions is 32,3% of all quotes, while the observed proportion among 'Challengers' is 44,4%. The difference is significant according to the binomial testing procedure of SPSS²⁴.

²³ Pearson chi-square has a value of 14,091, with 2 degrees of freedom. The significance of 0,001 implies that the relationship between cross-tabulated items is statistically highly significant in the sample.

²⁴ Observed proportion of negative "Challenger" quotes is compared to the test proportion was 0,323. Significance of 0,002 is based on Z approximation.

The inclusion of expressions about a positive feedback loop and ambiguous expressions partially support the former results. The ambiguous variable refers to situations in which the statement or quote provides an indication of support for both positive and negative feedback. Adding new categories reduces the number of cases in each cell, making statistical inferences more difficult. The relationship between strategy view variables with categories (negative, ambiguous, positive), and firm class ('BSkyB', 'Challengers', 'Others') is statistically significant, and also visible in Table 6.

Table 6 Firm class and strategic view cross tabulation²⁵

Firm	Negative feedback expressions	Ambiguous feedback	Positive feedback expressions	Total
BSkyB	10	3	42	55
'Challengers'	45	18	79	142
Others	52	21	192	265
Total	107	42	3	462

The time-series of negative feedback quotes informs that the firms expressed negative feedback in a rather constant manner. There are no observable peaks in the negative comments among 'Challengers'. The flow of announcements did not change during the study period, with the possible exception of the last months of 2002, after the industry shakeout and the introduction of the Freeview platform. In relative terms, BSkyB and its parent organisation had a more negative emphasis during the last months of the investigated period. However, the small number of negative comments by BSkyB makes it difficult to draw inferences on their evolutionary path.

The quantitative content analysis supports the view that firms searched in an imitative manner, did not explore new opportunities, and were inclined to follow others, thus not fully leveraging their distinctive advantages. The different analyses offered slightly different views on the firms. An analysis of quotes and statements portrayed BSkyB as a less imitative firm.

²⁵ Pearson chi-square has value 14,230 with 4 degrees of freedom. This would have implied significance (2-sided) of 0,007.

4.5.2 Qualitative comparative analysis on competitive topics

Announcement data gives the perception that the ‘Challenger’ group was mostly responsible for the negative feedback expressions. Therefore, BSKyB could be described as a firm with strong reliance on the positive feedback mechanism. This would characterise it as a pioneering industry leader with initiatives exploiting distinctive resources, an explorer of new avenues for its benefit, while also supporting industry development. The other evidence found in the narrative section largely supports the finding inferred from the quotes and statements. However, the narrative offers a complementary view in which BSKyB is not as strong, or was not always the pioneering force, interviewees and text documents even describing BSKyB as ‘obsessed’ with competitors, or sharing ‘industry obsession’. The examples suggest the ex post leader was not only an initiator, but also a follower itself. Further, they give insight how the powerful position of BSKyB was not evident when the events started to take place. It reached its leadership position only some time after introduction, and the firm was internally divided on the best possible digital strategy.

The vagueness requires further investigation of the causal conditions of imitation. I use a qualitative comparative analysis (Ragin, 1987; Ragin, 2000) in order to shed further light on the role of an industry leader. If the challenger firms are imitating the industry leader, it gives a benchmark for them. The picture changes if the industry leader acts as an imitator and the imitated. If the leader possesses both roles, the result suggests an equal view of how the participants are assessing the market.

Following the qualitative comparative case methodology tradition, I focused on the combinations of conditions in order to unfold the complexities (Ragin, 1987). The comparative method is interested in which combinations are associated with the particular outcome (Ragin, 1987). Therefore, I investigated the combinations leading to imitative behaviour. More specifically, I was interested to see, if combinations leading to imitation included BSKyB’s role as an initiator, or whether some other combinations were possible. The Boolean logic of expressing causal condition in the form of truth tables offers a way to summarise researched data. With even small number of comparable cases, a researcher can make causal inferences (Ragin, 1987).

This analysis took place after the need for new analysis was recognised, and therefore data manipulation was required. The narrative was written about the most central competitive phases, starting from the launch, competition over set-top boxes and content, leading to the industry shake-up. In the narrative, some minor phases emerged, such as cable industry consolidation and new product and service launches, which leveraged digital technology. The smaller competitive incidents were not as carefully observed in the media and the interviewed industry experts did not give them equal attention. For qualitative comparative analysis (QCA), I reread the material to identify with some less intensive periods in addition to the more visible competitive phases. I came up with 14 topics of the competition.²⁶ The different competitive topics provide the comparison necessary for qualitative comparative analysis. Sharing the same larger context, the competing firms have partially different conditions and competitive outcomes. The number of configurations (14) is in line with QCA applications, as Ragin (1987) suggests that the most appropriate number of cases is between 5 and 20 (Ragin, 1987).

After identifying the competitive topics, I tabulated the major characteristics of each of these case configurations. For that reason, I read 725 non-overlapping news items or quotes, with additional support from the interview data. The following table gives also a short description of the topic. Each one of them is mentioned also in the narrative.

²⁶ Most of the topics received quite coherent treatment both in the initial news and announcement material, and interviews. The iterative research process helped to find the themes, although some items were originally unnoticed. In the initial news material, there were reports about marketing bundles of channels. At that point the items were not classified as a news item at that point, because the pricing of bundles was not considered as a news event, nor they were supplied with a quote. However, the interviewees gave it a stronger role, and the material was reread providing data for QCA.

Table 7 Competitive topics

Configuration number	Topic	Description
1	Sponsoring set-top boxes	As firm sponsored customers with free or almost free boxes. This excludes the government's idea to catalyze digital switch-over.
2	BSkyB channels	As digital platform's own premium channels were wholesaled to other platforms
3	ITV channels	As parent organisations of terrestrial platforms were wholesaling premium channels to other platforms
4	Football content	As broadcasters were involved in publishing rights and ownership of football teams
5	Other provision of content	As firms were involved in bringing content to their channels and platforms
6	Installed base	Platforms emphasised in their communication their installed base of customers
7	Cable consolidation	As cable television companies consolidated
8	Interactive hardware and software	New product introductions after digital television
9	Interactive television	Interactive and enhanced television programs
10	Digital shopping	Digital home shopping and betting services
11	Commercials	Interactive commercials
12	Triple play	Internet, phone, TV services marketed as a bundle
13	BSkyB as an operator	The negotiations over terms of distribution of channels on satellite, and their access in the Sky Digital electronic programming guide
14	Channel bundling	When channels of programming were sold as bundles

Competitive topics are meant to be distinctive, although the content of the news item or statement would have provided material for several categories. Some of the topics seem to be residual classes, including 'Other provision of content'.

Competitive topics have different characteristics, including conditions associated with the outcome. The outcome here is imitative competition. The analysis was developed during the course of the study, which adds a word of caution. The investigation has been open to the actions of all companies, but its main focus has been on the actions of the major firms. Imitation by smaller, e.g., technology companies would have been

possible to detect, but I acknowledge that there is a bias due to the material used and the researcher's preoccupation with the broadcaster and platform side of the narrative. The problem is not necessarily a serious one. The defining issue here is to clarify the role of BSkyB as a pioneer, or as part of an imitative group. As this investigation is intended to clearly focus on the unsolved role of BSkyB, and not the totality of the question, the investigation builds on the earlier chapter. This processual research has led to a change in the dependent variable, as well. In the previous chapter, comments about negative feedback included hostility against competitors, as they were not building trust in the viability of the network. Following the network externalities rationale, this meant that while hostile to the competitor, the negative comments were also undermining the perception of the viability of the total market.

This QCA investigation takes the view that hostility may occur in imitative or non-imitative competition. The difference is evident in one stream of discussion. The case configuration 13 is about BSkyB as an operator, where it controlled access to satellite platform, and most importantly the Sky Digital electronic programming guide (EPG). ITV companies strongly opposed going to the satellite platform, so there was differentiation and hostility on their behalf that was present at the same time. In the previous content analysis, quotes on these items should be calculated as sign of a negative feedback loop, but in this investigation the outcome was calculated as an occurrence of non-imitative competition.

Imitation is understood as following the example of others with a similar approach. The emergence of new solutions and new programs is non-imitative, but tapping into same pool of resources is imitative. For a channel, buying new programs is non-imitative as it involves novel creative products. Buying rights for the same products is considered as imitative. Competition over new but similar resources is a critical borderline issue. Reflecting on the interviews, I came to conclusion that competition over football was imitative, while the different arrangements with interactive technology suppliers were not. This is supported by the rationale expressed by Noda and Collis (2001), in which positive feedback catalyses divergence and negative feedback congruence. Non-imitation would bring about new firms, new resources and new combinations into development, while imitation more severely limits the number

of new entrants. Football teams are similar in kind, while new technology and creative cultural products offer an unbounded number of variations.

The causal conditions investigated were selected after re-reading the data. I took notes when actors, types of actors, characteristics of actors, or events were associated with the competitive phase. Firstly I tried subjectively to understand their potential to cover the phenomenon i.e. leaving out the most idiosyncratic associations while avoiding tautologies. I came up with four conditions that were referred to in the written material and interviews. The conditions are the role of platform provider, 'Platform'; the centrality of participants, 'Centrality'; the role of BSkyB in initiating the competitive phase, 'BSkyB'; and the role of digital services in the particular competition, 'Digital'.

'Platform' as a condition refers to platform operators' role in the competitive phase. These firms include commercial, terrestrial, satellite, or cable operators, but exclude public broadcasters. The investigation of major competitive phases suggests that platform providers were inclined to imitative behaviour.

'Centrality,' as a condition refers to the average centrality of discussants active in the competitive topic. Due to material and research focus, the 'Platform' and the 'Centrality' are overlapping because the major platform firms are the most central firms, followed by the BBC. With the BBC, there is another distinction, as acquired cable companies were platform firms, but with no central position in the network.

The 'BSkyB' initiative means that the condition is true when the company launched the competitive issue at hand. The content analysis showed that the other platform operators and the BBC expressed negative feedback mechanism in their quotes and statements. This lends to the proposition that the latter firms' hostility was due to the leadership of BSkyB or, more generally, that imitative competition was a type of response against the leader. In that case, BSkyB's initiatives would have been the most obvious targets of such responses.

As the investigated topic covers a new technology introduction, it is justified to include it as a potential condition. The variable 'Digital' denotes the conditions of the significant presence of new technology in the particular competitive topic. As Noda

and Collis (2001) suggest, the emergence of new actors is logically associated with divergence and positive feedback (Noda & Collis, 2001). With new technology as a condition, we can evaluate how constant an association it has with non-imitative competition.

With a small number of configurations, the QCA method relies on binary categorisation of causal conditions and output (Ragin, 1987). Subjective binary categorisation is based on the earlier material. Conditions are marked as present if they exist, absent otherwise. I attempted to constrain my judgment by assigning the presence-absence dichotomies of almost equal sizes. Within each variable, there were from 6 to 8 existent conditions, and respectively eight to six times of absence. The limitation presented pressure to classify more configurations as having an ‘Absent’ condition than would have otherwise been the case. The classification mirrors the situation, at least in relative terms. The cases with more ‘Present’ conditions, received the correct classification, while less present conditions received the classification ‘Absent’. More information about coding is found from Appendix 7.7. The table in the appendix provides examples such as quotes, or excerpts from an interview as an illustration. They give advice on the reasoning behind the categorisation.

Table 8 Binary categorisation of configurations

Configuration	Centrality	Platform	BSkyB	Digital	Imitation
1	Present	Present	Present	Present	Present
2	Present	Present	Present	Absent	Present
3	Present	Present	Absent	Absent	Present
4	Present	Present	Present	Absent	Present
5	Present	Absent	Absent	Absent	Absent
6	Present	Present	Present	Absent	Present
7	Absent	Present	Absent	Absent	Present
8	Absent	Absent	Absent	Present	Absent
9	Present	Absent	Absent	Present	Absent
10	Absent	Absent	Present	Present	Absent
11	Absent	Absent	Present	Present	Absent
12	Absent	Present	Absent	Present	Present
13	Present	Absent	Absent	Present	Absent
14	Absent	Present	Present	Present	Present

The configurations are here summarised in Table 9. There are 2^k possible configurations with k as a number of conditions. In this investigation, there were 10 existing combinations, while six possible configurations did not exist. The computer software fsQCA produced the following truth table (Ragin et al., 2005).

Table 9 Truth table of case configurations

Centrality	Platform	BSkyB	Digital	Number of configurations	Imitation
Present	Present	Present	Absent	3	Present
Absent	Absent	Present	Present	2	Absent
Present	Absent	Absent	Present	2	Absent
Absent	Absent	Absent	Present	1	Absent
Absent	Present	Absent	Absent	1	Present
Absent	Present	Absent	Present	1	Present
Absent	Present	Present	Present	1	Present
Present	Absent	Absent	Absent	1	Absent
Present	Present	Absent	Absent	1	Present
Present	Present	Present	Present	1	Present
Absent	Absent	Absent	Absent	0	-
Absent	Absent	Present	Absent	0	-
Absent	Present	Present	Absent	0	-
Present	Absent	Present	Absent	0	-
Present	Absent	Present	Present	0	-
Present	Present	Absent	Present	0	-

The table offers the existing and potential configurations. The first row describes a configuration that led three times to imitative competition. The combination included the presence of the most central participants in the discussion, strong involvement of platform providers, the competitive topic initiated by BSkyB, and with no significant impact of new digital technology. The configuration with the opposite conditional values, and the opposite outcome was found once, as seen in the fourth row.

BSkyB had the initiative with most of the competitive topics. The analysis show that in imitative competition, BSkyB was usually the initiator and others followed. But the role of BSkyB and non-imitation do not perfectly associate. There were three instances where BSkyB was a follower. With the three most usual configurations, BSkyB had a role both in cases, where imitation was present and where it was absent.

The frequencies are as important in the comparative approach as in the statistical approach. The approach is sensitive to changes in configurations, which is

problematic if the dichotomies are not clear-cut. With a small number of cases, the selection of cases influences the results strongly. If new case configurations had been added, it is possible that a finding of necessary or sufficient cause would be eliminated (Mahoney, 2000). Because of the smaller number of cases, the QCA approach stresses that each separate configuration has to be clearly understood (Ragin, 1987). The familiarity of each configuration also helps the researcher to make additional conclusions. One potential conclusion is to consider the difference between the content of conditions and the implications of conditions ‘Platform’ and ‘Centrality’. The difference between conditions is the existence of the BBC in the former, and the smaller cable operations in the latter. All of the other major players are in both categories. According to the investigation, the first category is more associated with imitativeness than the latter, although the firms in the groups are almost the same. The distinctive outcome may be a result of a legitimisation effort from the BBC, in which it has a major role in providing variety in programming and service. The competition remained non-imitative when the BBC was actively involved, at least compared to a situation in which cable companies were present.

The existence of digital technology carries some weight, as there is a pattern of non-imitation if there are not strong opposite pressures. The similar role of the strongest players is associated with imitation, while the input of new technology works to the opposite direction, though maybe to a lesser degree.

The ‘Platform’ condition is present in each configuration that had an outcome of imitative competition. The result expressed by the fsQCA software states that the presence of ‘Platform’ is a necessary and sufficient condition for the imitative outcome (Ragin *et al.*, 2005). According to Boolean logic, to be a necessary condition, it has to be in every positive outcome, although it can be present also with negative outcomes. The sufficient condition implies that it is sufficient to produce a positive outcome, but it is possibly not the only cause for the result. As mentioned earlier, the classification schema forced some potentially ‘Absent’ codes to be marked as ‘Present’. The ambivalent coding was limited to the conditions ‘Centrality’ and ‘Platform,’ especially the latter. This implies their strong role if the forced coding had not taken place. However, with more ‘Present’ conditions even with non-imitative competition, it would have lost its status a sufficient condition.

The fsQCA investigation provided a complementary view to the problem. I used the methodology to compare similar conditions with a certain outcome. The existence of 'Platform' as a condition was seen as a major factor when competition was imitative. BSkyB's initiative on a competitive topic did not guarantee imitative or non-imitative competition. The BBC, with other content and technology participants, was offering more different ways to compete.

5 RESULTS AND SYNTHESIS OF THE EMPIRICAL CASE

This chapter aims to provide conclusions derived from theory and the empirical case. Firstly, the chapter summarises the empirical results. The effort continues by merging the insights from the case with the original nomological map. Revised concepts and relations to the network externality situation are described and explained. Based on these, a new description of the competitive dynamics is developed.

5.1 The three major competitive phases

The commercial launch of digital television set up the competitive scene. Ex post, it seems that the competition over digital broadcasting in the United Kingdom was already over before it had begun in 1998, due to the initially superior resources and technology of BSkyB. This was not, however, the perception in the industry at that time. BSkyB was strong in analogue pay-TV, but the position was not appealing according to industry experts. In fact, a business columnist described the situation of BSkyB on the eve of digital era in 1997,

“This is not the end of BSkyB’s dominance of UK pay television, but it is surely the beginning of the end” (Cool et al., 2000).

The interviewee 3 described satellite as “a minority platform”, appealing mostly to the ‘movie and sports enthusiasts’. In addition, the firm itself seriously doubted its capabilities for successful digitalisation. Both the interviews conducted before the launch of digital and in 2005 express, that BSkyB was not an obvious winner, although it was the leading actor in pay-TV market.

The ex-ante characterization of invincible BSkyB can be challenged on grounds of competitive logic. Had BSkyB been perceived as such an invincible competitor as it ended up being, it would have not make sense for competitors to ever challenge it. Even with a possible retrospective bias against the story given by the losing side, an interviewee provided a reminder that for a period, ONdigital was the company that got most positive attention in the public eye. The terrestrial platform was also the central focus of the technological development discussion amongst standard setting bodies and government.

BSkyB had certain key resources that turned out to be difficult for its competitors to overcome. Its satellite technology, analogue subscriber base, content portfolio, and financial resources, all appeared *ex post* to contribute to its competitive success. Had BSkyB been passive in competition, however, aggressive competitors could easily have pre-empted its advantages through active channel portfolio development, building on their own initial subscriber bases, and advances in terrestrial transmission technology. As noted in the case narrative, a cable operator even argued that its digital transmission capacity was superior to satellite.

The strategic initiatives of both BSkyB and ONdigital showed that they understood the potential benefits of first-mover advantages and positive feedback effects in creating a sustainable base of customers and complementary products and services. The existence of potential positive feedback effects and customer lock-in created an intense competition, because the competing firms knew that if they lagged behind, they might lose the whole game. There had previously been serious conflicts between the major companies, giving an additional reason for fierce competition. The competition started in the form of price subsidies that all actors engaged in and, consequently, did not provide any advantage to either of the two firms. The subsidised equipment catalysed the speed of industry growth as customers adopted the new services more quickly. The subsidies provided for the set-top boxes by the digital service providers were a major transfer of wealth from the platform firms to the digital equipment manufacturers.

As with the provision of free set-top boxes, the benefits of content competition were not leveraged by platform operators. Instead of creating a profitable positive feedback loop for them, the sponsorship in fact strengthened the negative margin-reducing effects of competition. More channels and other services were offered, with losses to the pay-TV firms. Channel line-ups were less distinctive, as television rights owners sold their channels to several platforms.

Buying television rights gave firms a possibility to pre-empt competitors. The auctions offering the pre-emption opportunities were visible, which worked in favour of the winner. By competing fiercely, all the participants were creating and sustaining customer interest over competed program types. The competition itself signalled that there was something valuable for the audience.

The decisive imitation rivalry between BSkyB and ONdigital took place in the premium sports bidding contest. BSkyB was able to bid the most to get the first-tier sports rights and ONdigital had to go for the second-tier sports channel with an equally high bid that it eventually could not pay back with its subsequent revenues. The ITV group had, in general, been restrictive in not delivering its premium channels to the cable and satellite providers, especially to BSkyB, in order to support its own ONdigital. However, ITV Sport, with a budget of £150 million (approximately US \$ 210 million), represented a turning point in this behaviour and it was made available to NTL subscribers, too. The imitative move by ITV to launch a premium sports channel was very risky, as it was based on the ill founded rational that the satellite platform would like to deliver the channel as well.

The challengers were tempted into an imitation race where they constantly matched the leader's offering, but with less optimal resources for the purpose. The competition was played out, however, according to BSkyB's rules, as they had initiated the set-top box subsidy game, building on their financial strength, and who had created a pricing structure that turned subscribers' attention to channel bundles and variety; a distinct strength also specific to BSkyB's satellite transmission technology. Other digital service providers adopted the set-top box subsidies, channel bundles, and eventually even accepted the role of BSkyB as a channel content supplier for their own platforms, giving up a major differentiation opportunity.

The third competitive phase depicts the market when the competitive pressure is relieved, at least temporarily. ITV Digital (the renamed ONdigital) went bankrupt and the two competing cable companies ended up in financial distress, forcing them to swap some of their debt for equity. BSkyB became a major winner of the business system competition as it could now renegotiate its contracts with its content suppliers, received an inflow of new subscribers, and saw the positive feedback effects now come in with full force. It is interesting to note that the period of intensive competition not only delayed the emergence of network externality benefits, but also that it ended up magnifying them later. The intensive competition had forced all of the competing firms to invest extensively in the creation of the new business system in the United Kingdom, and the resulting digital television penetration rates were significantly higher than anywhere else in the world. At that point, BSkyB could

benefit from the investments in marketing and business system creation that the now defunct competitor had made. Therefore, the firm was much better off than if it would have been if the creation of the business system had relied on only one core product provider.

The different views on BSkyB in the competition narrative and the quantitative analysis of quotes suggest how much more careful they were in their comments about competitors. Although, an industry leader has the best opportunities to succeed if it wanted to succeed in destroying the competition, their signalling efforts focused more on their own offering, digital advantages, and explorative actions. BSkyB gave the impression of being a strong market leader, and their problems were only brought to the public on relatively few occasions, although they gained much visibility. However, the leader did not create the market or the rules of the business during the first years of television, but carefully considered the actions of its main competitors. The clearest evidence on BSkyB's mimetic behaviour was given in Horsman (1998) and in the interviews, not in the sample of quotes found in the news announcements.

In the sample of quotes, BSkyB's competitors signalled negative feedback loops more often. Their announcements and news stories were aligned with the view presented in the qualitative reading of other media texts. Stressing the negative aspects could have been part of an intentional but flawed strategy of the challenger firms, as interviewees pointed out many managerial errors by ONdigital/ITVdigital and the cable companies.

The investigated period ended with the conclusion of rivalries. After the collapse of competitors BSkyB negotiated a stake in Freeview, which offered BSkyB an even stronger position, but the lull lasted for only a short while. Despite being outside the scope of the dissertation, there are signs that a new round of competition with many of the same actors has begun in the U.K. BSkyB launched a free satellite service in 2004 in order to compete with the Freeview offering. This competitive reaction is itself already being followed by a new free satellite venture. The following is a retrieved headline from the BBC website,

“BBC and ITV to start Sky TV rival” (BBC, 2005)

5.2 Concepts and their relations

The original nomological map was based on the core documents of the network externality discourse. The map was in the background of the case narrative, which served as basis for a revised version. The case evidence suggests four major modifications to the first nomological map. They relate to switching costs and sponsorship; management of expectations; the end result of ‘winner-takes-it-all’; and the managerial perceptions of the competition, or cognitions. Figure 12 depicts the new model of competition for dominance in network business systems.

In the case, the competitive phases involved sponsoring, which eliminated the importance of switching costs. If switching costs favour the first-mover, the challengers have an incentive to reduce them. But, the knowledge about this mechanism is dispersed in the industry. When an industry leader understands the mechanism, it can take an initiative on the issue. In the digital television case, there remained some obstacles to switching that were technological in nature. These were related to different channel carrying capacities and coverage. The positive loop of installed base and network viability was stated in the text documents and interviews.

The original model reflected the extant literature, which gives guidance for how to win markets with significant network externalities. There is a strong motivation to rapidly grow customer and complementor bases. Arthur (1996) offers weaker firms two reasonable alternatives; ‘slow death and grateful exit’, but the case evidence suggests that firms are willing to stay in the competition longer than seems rational, *ex post*. In the UK market, the firms continued to pursue a strategy of convincing customers to join their networks. Thus, ‘winner-takes-it-all’ is replaced by ‘delayed win’ in the iterated map. The seemingly irrational lengthening of competition is a pattern of behaviour also evidenced earlier in the British television industry (Ghemawat, 1997).

The delayed win is a result of a chain of feedback loops. The case evidence illustrates that competition continued firms’ histories of rivalry, modified by technological differences between the platforms, and with a strong belief in growth, implying trust in the principles of network externalities. Technological differences partially explained the differences in initial subscriber numbers. The case evidence suggests

that the industry shared a view of how firms should compete and where the competition should take place. Perceptions of how people saw the dynamics of markets were observed and already acknowledged when going through the news journal articles. However, the interviews offered a more comprehensive understanding of the industry-view. The new iteration of the nomological map brings the cognitive aspect to the front to explain especially the length and intensity of the competition. An interviewee's retrospective expression 'industry obsession' is a revealing comment on the idea of a shared, but not necessarily a productive agenda in the television industry. The available data suggested how the idiosyncratic histories were moulding the shared industry view in the first place. Potential factors include the history of the firms and earlier competitive battles, especially. These cognitions were maintained and revitalized in the competition. As television managers enacted the market, a closed-loop emerged, in which managerial views on competitive causalities became self-fulfilling prophecies (Weick, 1977). The competitive arenas were chosen, not only because it was reasonable in network context, but also because the participants shared the same view. As industry sense making was enacted, the market was created and responses to a new market situation occurred as they predicted (Weick, 1977).

The industry perception intensified the competition around two major topics, namely content and set-top-boxes. These competitive topics are future orientated, emphasizing the need to manage expectations of customers and other participants. An intermediate result was imitative competition, which itself was feeding the cognitions. The competition ends when the resources of most firms are exhausted in the 'obsessed' industry.

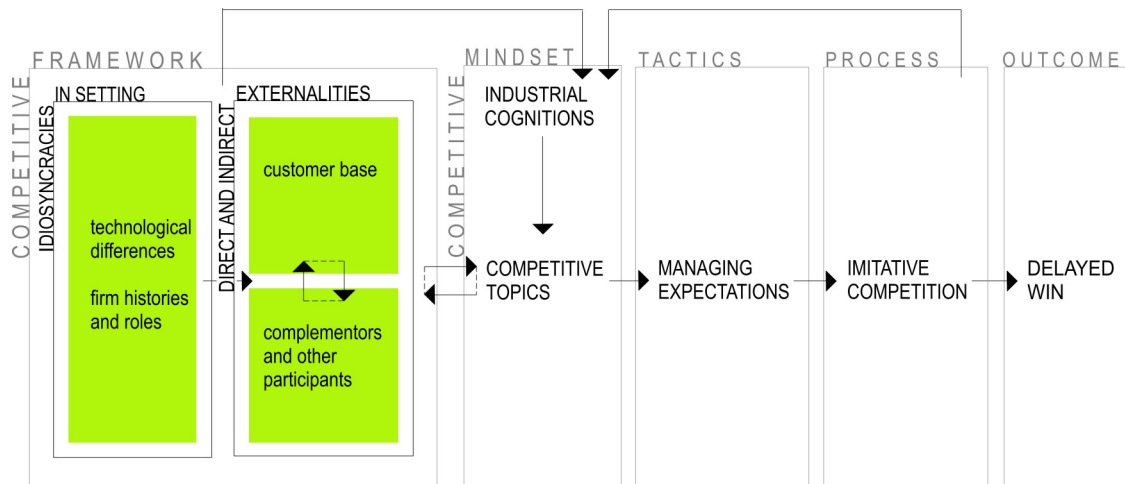


Figure 12 Cognition and externality driven competition for network dominance

5.3 Industry outcome resulting from the competitive dynamics

The dynamics of the competition for dominance in U.K. digital markets seems different than the network externality discussion would propose. As mentioned earlier, the idea that markets are ‘tippy’ (Besen & Farrell, 1994) has been the dominant illustration of network competition. The participants decide on their support of a particular network as soon as they can evaluate the future viability of the networks. Network participants favour networks that they expect to be the largest in the future. The seemingly larger network will find that newer arrivals to the game will join it. The combination of expectations and real growth makes the leading network grow even faster. All or most participants shift their custom from the seemingly less viable networks to support the leading network. A stable solution; equilibrium, is easily reached when a major portion of participants have joined the leader.

However, the case evidence does not support this straightforward view. BSkyB won the intense competition over network dominance at the end of study period after resource-draining and intense competition. Ultimately, the only beneficiary of the positive feedback effects was the survivor. The win was delayed and magnified, because the losing networks had given significant inputs to the development of the new business system. As a result, the United Kingdom enjoyed a leading position in

digitalisation. Had the digital television business been created without a significant competitive battle, the adoption of new technology would have taken significantly longer. Thus, the existence of short-term negative feedback dynamism in the form of ‘Red Queen’ competition (Barnett & Hansen, 1996; Barnett & Sorenson, 2002) magnified also the performance of the leader, but with a delay. The surviving firms reaped the benefits of the rapidly grown business system. I metaphorically name this kind of mutually strengthening interaction between positive and negative effects as a ‘positive feedback spring’. The metaphor illustrates how negative feedback seemingly delays the evolution, like a hand pressing a spring. Heavier pressure to the system keeps the spring in place and in a seemingly worse situation. After the release, however, the force acquired gives the system greater velocity.

On the other hand, in the metaphor ‘positive feedback spring’ the situation seems to worsen before the relief and strong movement. As with tipping markets, the end-result favours the leader, but the mechanism and timing differs. In the ‘positive feedback spring’, the competition ensures that more benefits are flowing to new adopters. This makes the ‘positive feedback spring’ more favourable to customers and suppliers. It may take some time before industry dominance is settled, and during the intense competition, the network participants are getting benefits from sponsoring.

After an intensive competitive period, the U.K. digital television markets changed in 2002. The later events fall outside the scope of this dissertation, but are nevertheless informative. The Freeview terrestrial proposal provides evidence how earlier imitation by pay-TV operators was seen as detrimental, but only with hindsight. In their application letter, the initiators of Freeview manifested how the new venture would be radically different than ITVdigital in most aspects including program offering, business model and over-all quality (Dyke & Abery, 2002). The regulators saw the situation similarly, and free-to-view offering was given a license. With a different kind of actor imposed by an authority intervention, the industry entered a new competitive phase. The earlier imitative rivalry came to a halt, and a more distinctive offering was offered to the viewers. The growth of Freeview encouraged other companies to follow suit. BSkyB started marketing a free satellite service, ‘Freesat from Sky’ in 2004. According to BBC news website, BBC and ITV are planning to launch their free satellite service as a counter-move to rival BSkyB (BBC, 2005). A

new round of imitative rivalry may have started with a functioning 'positive feedback spring'.

6 DISCUSSION AND IMPLICATIONS

The dissertation has sought to shed light on firm strategies in the competition for dominance of network business systems. This chapter summarises the previous chapters and evaluates the contribution of the study. The U.K. market offered a view that contributed to our understanding of the network externality phenomenon and to the relevant theoretical approaches. The main contribution of this research is an improved understanding of the dynamics of competition for dominance. In addition to theoretical implications, I will present the managerial, cultural and regulatory implications that the study has to offer. Furthermore, I give my view on the limitations of the study and suggest further research.

6.1 Summary of the study

In order to identify the relevant concepts in the research setting, I conducted an investigation of previous research on the network externalities phenomenon. Building on the most influential works on the topic, I built a nomological map of the relevant concepts of emerging network business systems competition.

The review of literature showed that the most important research had been conducted in the realm of economics, while the field of organisational studies had not produced research with a direct impact on the discourse. However, some of the relevant theoretical streams had investigated the same questions. I chose the evolutionary perspective on economics and population ecology for further inspection.

Ecological and evolutionary perspectives make inquiries on the same historical processes (Singh, 1990). They both investigate variation, selection and retention in and among organisations, and assume rigidity in organisations (Barnett & Carroll, 1995). While variation has been more central to the evolutionary perspective on economics, there is an emphasis on focusing on selection and retention among population ecologists (Ginsberg & Baum, 1994). In broad terms, the variation and adaptation stream emphasises positive feedback, while the selection orientated stream focuses on competitive effects and negative feedback. The two complementary research approaches (Astley & Van de Ven, 1983; Burgelman, 1991) were reviewed and their insights structured the following empirical work.

The competitive phases: ‘creating the market’, ‘the decisive battle’ and the emergence of ‘post-dominance’ in the framework of Suarez (2004) are observable in the narrative. The case narrative was divided into phases in an effort to reflect the content and timing of competition (Suarez, 2004), but the observed phases were linked and overlapping. During the first period, digital television was commercially introduced. The terrestrial proposition received more initial attention, while BSkyB had some technological advantages. Cable operators came later to the market, as their resources were tied up in consolidation efforts. Sponsorship of set-top boxes was the initial driver for digital diffusion. It was followed by competition for premium content. The actions of BSkyB and ONdigital showed that they understood the potential benefits of first-mover advantages and positive feedback effects. The competing firms increased their resources in order to win network dominance, and to avoid fatality. Their strategies were more imitative than distinctive. The existence of potential positive feedback effects and customer lock-in created an intensive rivalry, in which subsidies strengthened the negative margin-reducing effects of competition. The third competitive phase evidences the new market situation, in which three out of four focal firms are bankrupt or in debt-arranging agreements. The surviving firm could leverage the resulting viable industry ecology and the high digital television penetration rates catalysed by the high rate of investments.

Social network analysis visualised the evolution of the network and gave some descriptive data on the differences of the leading firms. Quantitative content analysis provided information on executives’ comments, reflecting views on positive and negative feedback loops. Qualitative comparative analysis emphasised how the strong role of platforms, or the focal firms was associated with imitative competition. In addition, it underlined, that the industry leader was also involved in imitation. The quantitative and qualitative comparative analyses triangulated the view of the intense competition.

The U.K. digital television evolution offered insights for altering the theoretical case. An analysis of the empirical case showed the significance of managing the expectations of network participants, and cognitive aspects were brought to the foreground. Also, new ideas on the dynamics between the major participants were developed. The case evidenced the simultaneous existence of both positive and

negative feedback mechanisms. This combination was communicated with a new metaphor, the 'positive feedback spring'. It illustrates that fierce competition requires vast resources. Firm's actions cannot make a difference between the competitive positions, as the moves are imitated and benefits are jockeyed out. The negative feedback works like a hand pressing a spring. Heavier pressure on the system keeps the spring in place and in a seemingly worse situation. The situation changes after the release and the systems is given greater velocity by the force acquired earlier.

6.2 Contributions to theoretical perspectives

The dissertation attempts to contribute to research on the competitive behaviour in a network business system. The starting point was the recognition that while the network externalities discussion had focused on the phenomenon, evolutionary approaches would add a dynamic insight to the subject. Among evolutionary approaches, evolutionary perspectives on economics have a high appreciation for path-dependencies and positive feedback effects, the economics-driven ecological approaches emphasise efficient population level competition and negative feedback.

In the analysis, I set out to take steps to bridge this gap between the different potential explanations of competitive outcomes in an analysis of the interdependency of positive and negative feedback effects. The evolution of the business system from its inception to dominance demonstrates the co-existence of both positive and negative feedback effects over time. The findings regarding their mutually strengthening effects and the metaphor of a 'positive feedback spring' strive to make this contribution. In the course of case evidence evaluation, cognitive aspects of managerial decision-making were brought to the foreground to complement the view.

The major contribution of the dissertation to cognitions and competitive dynamics is the attempt to describe and explain competition in networked markets more realistically. The dissertation investigates the markets in a longitudinal setting, an attempt warranted by earlier research (Gallagher & Park, 2002; Schilling, 2002) in order to avoid the usual neglect of processes (Wade, 1995). Much of the earlier work, with the exception of Gallagher and Park (2002) and Schilling (2003) has relied on quantitative studies or economic modelling, giving difficulties in finding new results. Suarez (2004) offered the dissertation a framework of competitive phases for

evaluating the battle for network dominance. The milestones were marked with different competitive actions, leading to a situation in which one technological design defeats its competitors (Suarez, 2004). The dissertation validated the framework by focusing on three competitive phases (Suarez, 2004). The phases were not distinctive entities, but strongly linked and overlapping. The framework provided tools to describe more fully the phenomenon in order to surface the limitations and further refine the network externality concepts.

6.2.1 The dynamics between the positive and negative feedback effects

Studies investigating an organisation's path-dependent evolution have often included positive feedback as a self-enforcing mechanism (e.g. Penrose, 1959; Nelson & Winter, 1982; Wernerfelt, 1984; Arthur, 1990; Barney, 1991; Dickson et al., 2001), with evolutionary perspective on economics (Nelson & Winter, 1973, 1974; Nelson & Winter, 1982) as a representative and the most influential framework. This dissertation follows the same tradition while focusing on a narrower topic. Among researchers investigating positive feedback dynamics, my contribution is mainly to the research on the effects of network externalities for the competitive strategies of firms (Katz & Shapiro, 1986b; Besen & Farrell, 1994; Katz & Shapiro, 1994; Wade, 1995; Arthur, 1996; Schilling, 1998; Schilling, 1999; Shapiro & Varian, 1999a; Shapiro & Varian, 1999b; Gallagher & Park, 2002; Schilling, 2002, 2003; Shankar & Bayus, 2003; Venkatraman & Lee, 2004). The above researchers leverage the previous work of network externality theorists with additional emphasis on managerial decision-making and actions.

Katz and Shapiro (1994) reviewed earlier network externality literature and stretched the idea of network markets to contain all strongly complementary products and services. The article discussed briefly how competition between the systems can be intense and costly. If managers think that only one firm or system is going to be the eventual winner, they are effectively bidding for future monopoly profits. The incurred costs obtaining industry leadership are recovered by higher profits after a shakeout. The Besen and Farrell article of 1994 was probably the first major attempt in the network externality research to give firms theoretically sound advice for choosing a strategies for standardisation. The article described and analysed the properties of network markets and competition types from a managerial point of view.

Their modelling effort emphasised first mover strategies in the case of incompatible standards, and intense conflict if a leader wishes to prevent followers using same technologies (Besen & Farrell, 1994). In contrast to the dissertation, the article does not analyse firms in a longitudinal setting, despite the article's recognition of the importance of history, path-dependence and future orientation of installed bases. The focus on consequences without specification of mechanisms is typical for economic theorists in the field (Wade, 1995).

Arthur (1996) and Shapiro and Varian (1999a; 1999b) offered a view comprising many of the elements of how to succeed in a network externalities situation. They also suggested that the dynamics are working in most industries but are more evident in high technology and knowledge intensive industries (Arthur, 1996; Shapiro & Varian, 1999a; Shapiro & Varian, 1999b). The articles and book by Arthur, and Shapiro and Varian offered plenty of anecdotal evidence for the dynamic interaction of different companies, as well as the popularisation of the theme. The aforementioned authors deduced managerial action points from the idea of increasing returns with the assumption of a positive feedback mechanism. The dissertation challenges the dominant view on rapid market tipping (Besen & Farrell, 1994), based on the industry-shared and anticipatory view of competition. Extending the reasoning by e.g. Arthur (1996), the length of intense competition measured in months or years is not so much of an issue, but rather the time between perception and action. For a rational or ideal manager in a losing network, the decision should be clear. A firm should quit the competition immediately when a manager realises the negative outcome of competition (Arthur, 1996). Although it took only four years to change the U.K. television market, with hindsight it can be asked why the participants invested more time and effort when it was supposed to be evident that the market was radically changing. The previous authors on network externality competition and increasing returns (e.g. Besen & Farrell, 1994; Arthur, 1996) seem to have overlooked some of the second-order effects of feedback loops. The core articles have not clarified the role of the decision-makers in competition in realistic terms. The decision-makers seem to have an outsider, or a rational position to view competition. The case narrative demonstrates that the firms were practising the teachings of network externalities, but could not correctly evaluate the situation as it developed. The idea of a virtuous circle involving installed base, availability of complementary products and

effective signalling (Schilling, 1998; Schilling, 1999; Dickson *et al.*, 2001; Schilling, 2002) is found in the U.K. market as well. But, the U.K. experience underlines that if everyone shares the idea, most of the participants cannot build a competitive advantage based on it. The case approach also contributed to this line of work by highlighting both the historical antecedents and future orientation of the competition.

Much of the work mentioning both network externalities and strategy issues has focused on the relative merits of first-mover advantages (e.g. Katz & Shapiro, 1986b; Lieberman & Montgomery, 1988; Arthur, 1990; Besen & Farrell, 1994; Arthur, 1996). In this context, these advantages stem partly from the switching costs (Klemperer, 1987; Farrell & Shapiro, 1988; Lieberman & Montgomery, 1988; Beggs & Klemperer, 1992; Kerin *et al.*, 1992). Previous research has showed the great importance of switching costs, including money, time and effort. This dissertation describes how the role of switching costs is diminished by sponsoring. The dissertation acknowledges the role of switching costs as a part of the initial setting, but rejects its importance during intense competition. Switching costs became a competitive issue, which is the reason why the costs went down. Gallagher and Park (2002) study on manufacturers of game consoles and software; managerial actions can be used and are used to manipulate switching costs (Gallagher & Park, 2002). This practice was in contrast to advice given, e.g., in Schilling (2003), on how industry leader can limit competition by increasing switching costs.

Sponsoring technology is an efficient way of building up a self-sufficient installed base (Rohlf's, 1974; Katz & Shapiro, 1986b; Besen & Farrell, 1994; Katz & Shapiro, 1994; Wade, 1995; Arthur, 1996). The Katz and Shapiro (1986b) article suggests that in the case of two competing technologies, the technology that will be superior tomorrow has a strategic advantage implying a second-mover advantage. The U.K. case evidence gave results that can be interpreted as a limitation to the applicability of their modelling findings. Sponsoring decisions ought to be understood in terms of competitive strategies, irrespective of technological superiority. The U.K. firms felt that they had the resources to commit to sponsoring, even when it was not financially viable.

In the dissertation, population ecology (Hannan & Freeman, 1977; Carroll, 1984; Hannan & Freeman, 1984) has been the major source of insights in the negative

feedback effect research tradition. The field has been contributing to research investigating the implications of mutualism and competition among interdependent firms (Hannan & Freeman, 1977; Carroll, 1984; Hannan & Freeman, 1984; Carroll, 1985; Barnett & Carroll, 1987; Barnett, 1990; Baum & Singh, 1994c; Carroll & Harrison, 1994). Theories of learning have switched the focus of the original structural inertia proposition in population ecology research, with implications for cognitive inertia and mimetic search in competition (Haveman, 1993; Greve, 1996; Baum & Haveman, 1997; Hodgkinson, 1997; Greve, 1998a, 1998b).

Distancing from the original inertia position, Greve (1998a) linked inertia with action rather than inaction (Amburgey et al., 1993). The line of work by Greve (e.g. 1996; 1998a; 1998b) on radio stations on different markets share the dissertation the scope on a content-driven business. Greve (1996) reasoned that uncertainty about the consequences of adopting a different market position leads to mimetic change, instead of inaction. In Haveman (1993), imitation was result of legitimation processes led by successful pioneering companies. Empirical support was found for how successful innovations were mimicked by spatially or socially close companies (Greve, 1996). The U.K. case shows, that the imitation is not confined to the follower companies. An incumbent firm may be inclined to follow the competitors in several competitive topics. A reason might be, that one cannot have ex-ante accurate knowledge on the potential superiority of a resource.

The dissertation contributes also to the occurrence and implications of 'Red Queen' competition (Barnett & Hansen, 1996; Barnett & Sorenson, 2002). Barnett, with Hansen and Sorensen (Barnett & Hansen, 1996; Barnett & Sorenson, 2002) applied the 'Red Queen' analogy to the field of organisation and management science. In 'Red Queen' competition subsequent competitive actions lead to pre-empting of the action by competitors (Barnett & Hansen, 1996; Barnett & Sorenson, 2002). When observed from outside, the system appears to be advancing very fast. When observed from within the system, there do not seem to be any significant changes taking place with respect to the competitive positioning (Barnett & Hansen, 1996).

The dissertation bridges network externality and population ecology by introducing 'Red Queen' competition (Barnett & Hansen, 1996) in the network externality context. The dissertation provides further investigation and validation, with new

methods and in a new industry, of 'Red Queen' competition. The U.K. experience underlines that even the benefits from positive feedback mechanisms can be jockeyed out. Attempts to pre-empt some benefits from competition is like anticipative mimicry. In case of significant competition, there is strong incentive for a challenger to reduce costs for switching in order to build a larger base. However, the incumbent has the same knowledge, and may try to overcome the situation. The case narrative showed how BSKyB and the challengers operated in this fashion. If both types of firms attempt to rush in front of the other, anticipating changes, the game will start earlier.

The study follows the competitive situation a step further than the earlier researchers have done. The changing dynamics of the negative and positive effects complements earlier results. In comparison, a study analyzing both positive and negative feedback mechanism on telephone company strategies found positive forces more significant (Noda & Collis, 2001). In 'Red Queen' studies, the investigation has not followed what happens after resources are exhausted. The 'positive feedback spring' favouring the original leader is an attempt to widen the longitudinal setting of 'Red Queen', and proposes an outcome of 'Red Queen' competition. The 'Red Queen' analogy has not been used earlier in a network context. The proposed 'positive feedback spring' metaphor also directly contributes to an emerging avenue in competitive action research, which Ketchen et al. (2004) term 'competitive interaction scenarios'.

6.2.2 Cognitive perspectives and rivalry

As suggested in the previous chapter, mimicry is not restricted to situations where smaller firms follow successful incumbents. Rather, all the participants with their different inputs are creating the ways how the markets work. This relates to cognitive aspects of competitive dynamics including research on sense-making practices (Weick, 1977, 1993; Reger & Palmer, 1996; Ocasio, 1997; Bogner & Barr, 2000) and competitor constructed rivalry (Porac et al., 1989; Abrahamson & Fombrun, 1994; Porac et al., 1995; Rindova & Fombrun, 1999; Rindova et al., 2004)

Firm managers focus their attention in a way that has an effect on the behaviour of a firm and industry (Ocasio, 1997). The concept of industry-level focus highlights how industry participants selectively focus their attention on a limited set of issues that

represent problems or opportunities to the industry (Hoffman & Ocasio, 2001). Interactions between firms and its different constituents with e.g. the media as an intermediary give rise to an industry macro-culture (Abrahamson & Fombrun, 1994; Rindova & Fombrun, 1999). Shared assumptions about market structure help to define the competitive arena and the rules of the competition (Porac *et al.*, 1995; Bogner & Barr, 2000). The market rivalry is socially constructed, where managers discover, learn, and enact market positions (Porac *et al.*, 1995). Competition takes place over the interpretations of multiple constituencies, not only over material resources (Rindova & Fombrun, 1999).

There are several reasons, why cognitions shaping firm and competition are of self-enforcing nature. A firm's identity is largely shaped by its reputation, which itself may reflect observers' cumulative interpretations rather than the current state of the firm (Rindova & Fombrun, 1999). Cognition influences not only the selected means to achieve goals, but also the goal setting process (March & Simon, 1958). The cognitions have an effects on actions, but the actions carried out also affect the cognitions (Porac *et al.*, 1989; Weick, 1993; Rindova & Fombrun, 1999). Managerial views on competitive causalities are self-fulfilling prophecies (Weick, 1993). The escalation of actions may result in a commitment to beat the enemy-rival, and improving relationships may prove difficult (Rindova *et al.*, 2004).

The narrative from television industry evolution in the United Kingdom fits the ideas summarised above. Many actions of the focal firms were hostile, but they shared the similar view on the competitive arenas. The escalation of competition was a resource-draining process for the platforms. A series of studies focusing on competitive groups in the Scottish knitwear industry (e.g. Porac *et al.*, 1989; Porac *et al.*, 1995) considered the shared understanding of the market characteristics among spatially and socially proximate managers. In socially constructed market rivalry the participants determine the competition and competitors, 'competitive arenas' and 'rules of the game' (Porac *et al.*, 1995), a notion shared also in this dissertation. The television case shows how the industry leader had the initiative, at least in relative terms, informing that it had the better ability to understand new market demands. The case suggests, however, that it is not only about the leader finding the proper new way, but that there is a strong element of others accepting the leadership even without clear

understanding of what is really good for their own companies. This resonates with the discussion in Hodgkinson (1997) describing how entry by leading firms offers a highly visible stimulus which narrows actors' attention.

Homogenous industry cultures increase the level of inertia, and the level of similarity among competitors (Abrahamson & Fombrun, 1994). It has been found that cognition of managers reiterates earlier schemas in new surroundings, even at the expense of relevant objective characteristics of a current situation (Abrahamson & Fombrun, 1994; Reger & Palmer, 1996; Hodgkinson, 1997). The shared industry view by the U.K. decision-makers may explain why the firms did not see differentiation as a successful way to compete. In the U.K., the commercial terrestrial operator was willing to reduce the own content of its parent organisations in favour of their strongest competitor's channels. This expensive mimetic change was hardly criticised at the time of action. With hindsight this seems surprising and suggests that mimicry could be a ruling principle even in industries seemingly favouring strong variety.

The mental models of managers may determine the type of adaptation to a new strategy (Greve, 1998a), while the Miller and Chen (1994) article suggested that threatened managerial egos can be the reason for inertia and inability to effect strategic change (Miller & Chen, 1994). The idea of cognitive inertia in managerial action (Greve, 1996; Reger & Palmer, 1996; Hodgkinson, 1997; Greve, 1998a) was further supported by the case evidence. There were references to e.g. 'industry obsession' and personal characteristics of managers linking cognitions with unproductive behaviour.

The inertia of active organisations (Amburgey et al., 1993) is difficult to stop when firms observe similar competitors and remember their competitive past. The firms most active in the digital diffusion shared a history of business conflicts, and the pattern continued during the observation period. The case interviews suggest that even the new practices may be reflections of history or results of relatively local searches. Two of the U.K. firms had had intense rivalry already before the digital era, which provided experience on how to manage competition. This resembles the results of Reger and Palmer (1996), in which they conclude that managers navigate in new competitive environments that contain some elements familiar from the past. Inertia makes it difficult for managers to update their cognitive maps quickly enough for

turbulent environment (Reger & Palmer, 1996). There are several ways a real-life manager can find a solution with stabilising previously known elements. In an uncertain situation, she can find advice from history, but the closest source of information may be the competitors (Greve, 1996, 1998a).

In the case study of IBM, Rindova and Fombrun (1999) suggested that industry conditions are in flux by actors' interpretations of events, while learning by the moves and signals by other actors (Rindova & Fombrun, 1999). If decision-makers reflect signals to their past experiences, network externalities make the interpretation even more challenging. Firms facing significant network externalities are driven by expectations, which may have implications for sensemaking practices. Contributing to this line of research, I propose that firms might experience 'tippy markets' of managerial ideas, in addition to 'tippy markets' of products and services. The firms shared a managerial idea that network externalities existed, and actions to build an installed base led to imitative sponsoring. If they had not scrutinised competitors sharing the same competitive view, the pressure to imitate would have been less. The future-orientated managerial view spread rapidly through the markets, and settled itself as a 'standard'. The bandwagon effect on building momentum is conceptually different than an externality effect associated with network size, as Cusumano (1992) states, but they were closely related in the case. The time-critical bandwagon was built on the shared, although not necessarily explicit, management principles set by network externality ideas. This is a context specific notion, because the future orientation of the perception made the diffusion faster. It was safer to share the view, because time was a key element in the network externality game.

Recently, much work has been done on the dyadic nature of business relationships. The competitive action research stream investigates competitive moves, and its traditional focus has been on competitive actions and responses to them (Ketchen et al., 2004). The work provided methodological assistance, and the findings are related to the research stream. Its major line of findings has been on how aggressiveness of firm actions affects the market share of the industry leader (Ferrier et al., 1999; Ferrier, 2001; Smith et al., 2001). So far, the competitive action stream has repeatedly suggested that the number, the unpredictability, and the breadth of competitive actions by a challenger firm has a positive affect on acquiring market share from the

incumbent (Ketchen et al., 2004), while in the long run the activity may prove destructive because of an escalation of competitive responses (Rindova et al., 2004).

I would complement the view by arguing that the potential actions and reactions are part of temporally and spatially located rules of engagement. Not only the number or breadth, but also the perceived quality has important consequences. Most of the actions are signalling actions, because they are made public. This puts more emphasis on language, perceptions and shared assumptions. Rindova et al. (2004) stated that the use of 'war-language' can shift the focus to beating the enemy-rival instead of optimising profits (Rindova et al., 2004). Promoting 'aggressiveness' in their appearance may distract managers when they are contemplating tasks for expectation management.

In addition, I suggest that competitive actions might be different in a network setting compared to purely dyadic firm relation abstractions. The number or breadth of actions may measure a firm's viability or strength improperly if competitors are trying to negatively influence the perceptions of other participants. Signalling a negative feedback loop gives customers or complementors less confidence about the firm in question, while focusing on the positive feedback mechanism has a stronger favourable effect on the market, and also on the firm.

6.3 Managerial implications

Digital television services are in the process of being started and gaining popularity in many countries. Since the business system dynamism and the competitive implications of entering the digital television business are not well known, broadcasting companies in many countries have been hesitant in preparing their entry to this business area. The emergence of the digital television business system in the United Kingdom provides the first complete 'laboratory experiment' revealing what are the drivers of success and failure in the digital television business.

Understanding the importance and implications of initial conditions, competitive actions, and the dynamism leading either to business system dominance or failure is likely to be valuable for managers competing in a business area. The rivalry for network dominance is an area that has also wider interest in other industries with

significant network effects. The dissertation provides a decision-maker a coherent way to understand the industry and act on the information. The implications of the study have therefore potential significance in other industries, as well.

Building a viable network of complementary products and services involves a large amount of resources. The metaphor of ‘positive feedback spring’ describes a situation, where large investments by all major participants contribute to market creation, benefiting customers, and complementary product and service providers during the intense competition. As the losing networks have invested in building a viable new market, it can be tempting for the industrial leader to ‘lure’ new competitors to enter if they finally lose the game. The case evidence suggests that inviting competitors can be profitable when the demand for an offering is dependent on the offering of several other products and services. This interdependent demand is evident in many non-high technology markets e.g. with stores and their offerings.

The case evidence suggests that risks in network competition are even greater than predicted in most of the previous studies on the subject. The competition for network dominance may be highly rewarded, but the intensity puts an additional strain on firms. In addition to a financial burden, competition has several aspects requiring managerial attention. The technological dimension has only a limited value in explaining the difference between the winner and losers of network evolution. A network offering is a combination of products and services, but building on them rests a social construct. The competition is played not only by offering products and by services, but also people’s perceptions are a major competitive arena. In order to gain a leading position, the image of leadership and innovation have to be communicated clearly to the consumers, but also to the competitors, and to other participants in the market. Focusing on positive feedback mechanisms helps a firm to distinguish itself from the more imitative competitors.

When more firms understand the importance of positive feedback mechanisms, it is more difficult to differentiate. The managers focus their attention on similar points, and crowding might occur quite rapidly. If the managers share the view e.g., of the necessity of the future size of the installed base, the sharing itself catalyses the diffusion of the managerial view. The competitive arenas and rules of the game are quickly established, even in new surroundings, with intense competition. There is a

danger, that escalation of action may distract managers who favour beating the competitor, instead of profit optimisation, as noted in Rindova (2004).

The complementary providers of a product offering are often the hinge factor in network evolution, when the consumers decide which networks are the most viable. While consumers examine the breadth and quality of the network offerings, the offerings are largely a product of the combination of complementary products and services. Therefore, the entry decisions and network choices of complimentary product providers have a major impact on the success of a focal firm. As the complementary firms act on their perceptions of the market, the feedback loops of expectations of network viability are significant. Managing expectations in reliable manner at different levels is critical for a network success.

The managers may see the role of their firm as an active first-mover or as a mimetic follower. This is a choice involving judgments on several levels, including personal and firm level evaluations. When evolution is path-dependent on the histories, the managerial freedom to operate may be limited. It is difficult for a firm to choose a strategy that is not closely related to its past, or to its social proximity. However, even in rigid organisations, a better sense of the dynamics may help managers to realise what kind of future is in the making.

6.4 Implications for regulators and television culture

Digitalisation has given a possibility to offer niche channels, with minority appeal. The smaller audiences provide less revenue base, but the streams can be viable even when funded with advertisements. Minority channels can offer a better option than mass-audience channels, because it is a way to escape the intense competition (Liu *et al.*, 2004). The U.K. case proves that channel variation offered a way to commercially differentiate, but often the firms favoured the imitating behaviour of the other similar companies. Fragmentation is also a result of competition over television publishing rights (see e.g. Boardman & Hargreaves-Heap, 1999), which has been proven to be a resource-draining experience.

Suggestions to restrict pay-to-view broadcasters from certain events can be rationalised using the idea of network externalities (Boardman & Hargreaves-Heap,

1999). The proponents of the idea argue that there are shared externalities in consuming cultural products. The exclusion of mass audiences would be harmful to the social welfare, if, e.g., a large number of people start conversations about sporting events they have seen on television, and these mutual experiences bond the participants, which is important for community building (Van der Wurff & Van Cuilenburg, 2001). A pay-TV owner uses pricing in order to get most of his exclusive television rights, while an advertisement funded, free-to-view channel has an incentive to get as many viewers as possible in a chosen segment. The number of potentially alienated sections of the audience is larger with pay-TV, than with channels paid by commercials or license fees, but it does not mean the disappearance of common topics for discussion. If there is a genuine and strong interest viewers would acquire the possibilities to watch the events. Viewers would prefer consuming more money on television, and this money would be taken from some other spending. On the other hand, if there were not genuine interest in participating in a particular event, the mass audiences would be created elsewhere e.g. new sporting events. Therefore, the alienation arguments hold only if there is a very widely shared understanding of which events will remain with significant network externalities, with the additional premise that a pay-TV operator would charge viewers in a manner that would alienate significant numbers of potential viewers²⁷.

The U.K. experiences can shed light in relation to using the network externality concept in sharing cultural products. The case study shows that there was a tendency to use television rights aggressively by different participants. However, during the first years of digital television, the benefactors were not the pay-TV operators. The surplus went to the consumers and the initial rights owners, because pay-TV operators wanted to offer programming. The firms used predatory pricing, which did not reflect well the costs that the firms had to pay. The operators had the incentive to build large audiences, because only a large installed customer base was seen viable. Therefore, the pay-TV operation provided television for larger audiences than alienation arguments could explain.

²⁷Unsurprisingly, watching free-to-view channels is not free, either. The costs may include price of television set and other equipment, license fees, and even price for electricity. These costs alienate a proportion of potential viewers and discussants.

Digitalisation involves the entry of new organisations. In modelling the social welfare and television economics, it has been found that multiplication can provide an improvement by introducing a closer match between a consumer's taste and the offering (Liu et al., 2004). The financial motivation for multiplication of channels is evidenced in the case, which initially favoured viewers. Firms were making losses when they delivered their content in order to build a winning network. The multiplication of channels has the danger of lowering the quality of programming, if the resources for additional programming hours do not increase (Liu et al., 2004). Van der Wurff and van Cuilenburg (2001) modelled and tested how multiplication of channels in moderate competition increase programming variety, while diversity declines in extreme, or ruinous competition (Van der Wurff & Van Cuilenburg, 2001). In the Netherlands, the intensity of competition led to imitative behaviour in the digital television business. The U.K. experience supports largely the economic model of the Netherlands. The point of difference is that the perceptions of the competition have an effect on competitive actions, and in intense competition, perceptions may play an even stronger role. If the industry-shared cognitions view variety favourably, competition will take the form of variety competition. If the firms feel that the revenue streams are protected from imitation, they act accordingly. The BBC as a publicly financed company had a serious challenge to induce variety to the listeners and viewers. It participated in sports publishing rights auctions, in which its input to programming is not significant, as some other firm would have shown the events anyway. However, public broadcasters e.g. provided first sports and entertainment programs with multiple screens, which paved the way for others. The developmental work offered programming variety, which is one of the least controversial roles of a public broadcaster. In addition, as a major feature of the industry was a culture of imitation, the example was a refreshing reminder to others that there are various types of competition.

The regulators should set incentives that make the ecology, and not necessarily individual firms prosper. This idea could be seen as the background for BBC's platform neutral policy, as they were present in satellite, terrestrial and cable. This improved the competitive ecology of the platforms and invited new content providers by showing their viability in the eyes of a major player. Setting proper incentives have the possibility to improve the ecology. Setting boundaries often have the adverse

effects of increasing rigidity, which is a reason why limiting competition should not be taken as a guarantee of program variety. The intensity of competition and the resulting failed firms in the U.K. did not have serious effect on television, as there is a dynamic industry serving different audiences. Firm competition may benefit the other participants more than the competitors. The case evidence suggests that the U.K. remained a leading country in the digital era, even when three quarters of its commercial digital platforms failed. New firms emerged, and in the course of competition, new kinds of services had emerged.

It might be useful to compare the dynamic evolution in the U.K. and a more stagnant case of Finland. Industry-shared perceptions define where the firms want to compete, as was seen in the U.K. Commercial platforms, even with the strong involvement of a public broadcaster, competed on arenas of their selection, where programming variety played an important but subordinate role. If they had selected otherwise, e.g. preferred program quality, or stability between the focal firms, the outcomes would have been different. One can argue, that the Finnish industry-shared view about digital television has not promoted growth, or high-risk ventures. Finnish broadcasters have all survived the same time period, and the competition has stayed relatively calm. The British viewers and producers of complementary services benefited from the competition, whereas similar dynamism has not happened in Finland.

Based on the comparison, one can propose that an industry to take a globally leading role has to have an industry culture pushing competition towards it. The authorities should aim for actions that are coherent with the policy objectives. Regulators should consider how to mould the cognitive perceptions of firm managers e.g. by setting industry wide incentives that promote program variety and quality.

6.5 Limitations and future research

Several limitations that provide potential starting points for future research can be identified. Firstly, I examined dynamism in one network business system for a limited period of time only. The findings are case-specific and cannot be directly generalised to any other business system. Some distinctive features in this case include the competitive histories of the firm, and the role of the U.K. and European Union authorities in the regulated broadcasting industry. The firms had experienced rivalry

before digital era, and the actions taken by regulators were in encouraging competition. Future research could extend the analysis of the relative importance of initial resource endowment, feedback effects, and competitive actions also to other settings. An immediate step could be to expand on this dimension by studying digital television broadcasting service introductions in other countries. This would provide relatively similar settings where variability due to different types of technologies could be held constant. Secondly, my data consisted of news reports and announcements, and a small number of interviews. The unobtrusive data did not provide the perception of managers, while the retrospective information had its own biases. On the other hand, qualitative action research involving an on-site investigator is a methodology that could help in providing a relatively good complementary picture of how managers perceived their competitors and competitive action.

The dissertation process has opened new avenues for further research in competitive action research. The competitive action research has largely relied on news event data as an independent variable, with different performance measures as dependent variables. Including network positions and different motivational factors can shed more light on the question of the causality of actions and performance.

I share the view of Schilling (1999) in asking for further investigation of causal models linking technology adoption with the installed base and complementary goods. The case suggested that the firms shared an understanding of the network economics. If the new knowledge of the phenomenon can truly change the behaviour of the studied objects, the results found in managerial science become rapidly obsolete if the focus of the studies is poorly specified. In more conceptual terms, this is about feedback loop between research and management communities. Firms can act in anticipation, as they better understand the possible near-time consequences of competitive reactions. Obtaining more solid and time-independent results would warrant new attempts to investigate higher-order actions, and more theoretical work on the feedback loops.

7 APPENDICES

7.1 Details on selecting scientific articles and data retrieval

The impact factor in the ISI Journal Citation Report was primarily used for journal selection. The impact factor is the frequency of citations of an article of a particular journal. It is calculated by dividing the number of current citations to articles published in the two previous years, by the total number of articles published in the two previous years. The calculation is made annually for every journal in the database. The calculation of impact factors was available from the ISI Journal Citation Report Social Science 2002 edition. The Social Sciences edition used contains data from some 1,500 journals in the social sciences.

The evaluation included journals in the areas of economics, management, and business. The division of journals was given in the ISI Journal Citation Report. The top 20 journals from each of the three areas were included. Because of the overlap in business and management, the number of journals was 52. The calculation was filed in 2. - 5.1.2004.

A list of the original journals included in the bibliometric analysis of network externalities/effects is found below. An asterisk (*) is given to articles that were categorised as business journals by ISI Journal Citation Report. Additional 14 journals were added to the original list following a procedure (Parvinen, 2003) which relies on a readership survey organised in U.S. business schools (Siggelkow, 2001) and are marked with (+). These additions were those journals that were the most respected (outside the original list of 52) amongst the faculty of prestigious U.S. business schools' strategy, organisational behaviour and economics departments. The information was retrieved from a readership survey by Siggelkow (2001)

Table 10 List of journals

Name of the journal
ACADEMY OF MANAGEMENT JOURNAL (*)
ACADEMY OF MANAGEMENT REVIEW (*)
ADMINISTRATIVE SCIENCE QUARTERLY (*)
AMERICAN ECONOMIC REVIEW
BROOKINGS PAPERS ON ECONOMIC ACTIVITY
ECONOMETRICA
ECONOMIC GEOGRAPHY
ECONOMIC POLICY
ECONOMY AND SOCIETY

HARVARD BUSINESS REVIEW (*)
HEALTH ECONOMICS
HUMAN RESOURCE MANAGEMENT
INFORMATION & MANAGEMENT
INTERNATIONAL JOURNAL OF ELECTRONIC COMMERCE (*)
INTERNATIONAL JOURNAL OF RESEARCH IN MARKETING (*)
JOURNAL OF THE ACADEMY OF MARKETING SCIENCE (*)
JOURNAL OF ACCOUNTING & ECONOMICS
JOURNAL OF BUSINESS (*)
JOURNAL OF COMMON MARKET STUDIES (*)
JOURNAL OF CONSUMER RESEARCH (*)
JOURNAL OF ECONOMIC GROWTH
JOURNAL OF ECONOMIC LITERATURE
JOURNAL OF ECONOMIC PERSPECTIVES
JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT (*)
JOURNAL OF FINANCIAL ECONOMICS
JOURNAL OF HEALTH ECONOMICS
JOURNAL OF INFORMATION TECHNOLOGY
JOURNAL OF INTERNATIONAL BUSINESS STUDIES (*)
JOURNAL OF INTERNATIONAL ECONOMICS
JOURNAL OF LAW ECONOMICS & ORGANISATION
JOURNAL OF MANAGEMENT (*)
JOURNAL OF MARKETING (*)
JOURNAL OF MARKETING RESEARCH (*)
JOURNAL OF ORGANISATIONAL BEHAVIOUR MANAGEMENT
JOURNAL OF POLITICAL ECONOMY
JOURNAL OF PRODUCT INNOVATION MANAGEMENT (*)
JOURNAL OF RETAILING (*)
JOURNAL OF THE ACADEMY OF MARKETING SCIENCE
LEADERSHIP QUARTERLY
MANAGEMENT SCIENCE
MARKETING SCIENCE (*)
MIS QUARTERLY
NBER MACROECONOMICS ANNUAL
ORGANISATION SCIENCE
ORGANISATION STUDIES
ORGANISATIONAL BEHAVIOUR AND HUMAN DECISION PROCESSES
QUARTERLY JOURNAL OF ECONOMICS
RAND JOURNAL OF ECONOMICS
RESEARCH POLICY
SLOAN MANAGEMENT REVIEW (*)
STRATEGIC MANAGEMENT JOURNAL (*)
WORLD BANK RESEARCH OBSERVER
AMERICAN JOURNAL OF POLITICAL SCIENCE (+)
AMERICAN JOURNAL OF SOCIOLOGY (+)
AMERICAN SOCIOLOGICAL REVIEW (+)
INDUSTRIAL & LABOR RELATIONS REVIEW (+)
INDUSTRIAL AND CORPORATE CHANGE (+)
JOURNAL OF APPLIED PSYCHOLOGY (+)
JOURNAL OF ECONOMIC BEHAVIOUR & ORGANISATION (+)
JOURNAL OF ECONOMIC THEORY (+)
JOURNAL OF FINANCE (+)
JOURNAL OF LAW & ECONOMICS (+)
JOURNAL OF MONETARY ECONOMICS (+)
JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY (+)
JOURNAL OF PUBLIC ECONOMICS (+)
REVIEW OF ECONOMIC STUDIES (+)

Two article searches were conducted using the journal lists. The retrieval was conducted using ISI World of Science, which is a repository for three major databases. According to the ISI World of Science website, “The Social Sciences Citation Index is a multidisciplinary index to the journal literature of the social sciences. It fully indexes more than 1,725 journals across 50 social science disciplines, and it indexes individually selected, relevant items from over 3,300 of the world's leading scientific and technical journals.... Average 2,900 new records per week.... Includes approximately 60,000 new cited references per week...”

A search was made to find articles concentrating on the topic of network externalities, published in the above journals. As the aim was to analyse the discussion of network externalities, the search words were chosen accordingly. The search words were ‘network externality’, and ‘network effect,’ including plural forms. The total number of retrieved articles was 120. The searched articles were from the period 1.1.1986 - 10.01.2004, according to ISI Web. In practice the first article was published in August 1986 and the last articles in December 2003.

Computer software by Henri Schildt called Sitkis was used to download data from the ISI Web of Science to an Access database and to improve the data quality of the original database (Schildt, 2004). The retrieved articles cited another 4259 texts of which 264 were discarded by the program. The errors were due to unidentified marks in the downloaded files, e.g. asterisks. The report produced by the software showed which kind of citations were left out. I classified the abandoned citations by interpreting the information of discarded citation. According to my judgment, 75 discarded citations were from government, organisation, industry or company statistics, or similar numerical information, 103 referred to newspaper, or trade journal articles, 51 were from scientific articles and 35 citations were not obvious enough to be classified. It can be judged that the first two categories represent secondary data for researchers, without theoretical development. The last two categories may have some impact on the scientific discourse, but only in significant numbers. The 86 discarded scientific, or undetected articles represent only 2% of the citation population. The error report also suggests that every dismissal referred to different citation, which makes it more unlikely that any of the abandonment of any of the discarded citations could have had an impact if it had been corrected individually.

The number of 120 citing articles was then reduced to 119 after reading the abstracts of these articles. The topic of the article omitted was 'the charisma attributes of individuals', which seemingly did not have a clear relevance to organisation level subjects.

A source for error in bibliometric studies lies in the fact that part of information in the original databases is misspelled or not uniformly coded. Journal names and author's first, or second name initials were notified in various ways. Careful checking was made to minimise the problems concerning inaccuracy in document information. The Sitkis-program was used for correction. The article citation database of 119 articles was first checked by author names, and their respective article information was checked similarly. In the course of inspection, data entries with almost similar author or journal information were looked at to find misspellings e.g. Brynjolffson, Brynjolfsson, Brynjolfson.

A document may have been published in different outlets, e.g. a highly valued article may have many reprints. Everett M. Rogers wrote in his preface of his fourth edition, "I have once again titled this book Diffusion of Innovations to identify it with the forty-year sequential tradition of diffusion studies marked by my 1962 book of the same title." Following this, reprinted articles of the most active writers were identified with the original if found. The aim was to combine references made to re-prints, and book editions as references to one, original article. This correction procedure was made understanding that books, or reprints may or may not change their content between the editions. The seminar-papers having a more than years of separation to the article were treated as separate articles. Compiled, edited books consisting of different articles posed a problem, as the references were not made in a unified manner. This study used the same information as the citer. An additional correction was made for correcting the problem of software, which did not recognise a difference among articles written by the same first writer during the same year for a particular journal. As Joseph Farrell was a first-writer for two different articles in Rand Journal of Economics in 1988, the software combined the citations. Two names were given to the journal to separate the articles.

A separate procedure was made to check that journal names were spelled in a unified way. It has to be noted that some of the misspellings and notation differences may

have gone unnoticed. This is especially the case if the first letters of the author's last name were misspelled, or the name of the journal, or article was significantly differently abbreviated. If the remaining errors were dispersed equally, they do not have an impact on the relative merits of separate articles.

After the corrections were made 3855 references were left in the chosen articles. Some of those references were self-citations i.e. an author is citing her other document. Following e.g. Ratnatunga and Romero (1997), self-citations were not discarded.

To evaluate the cohesiveness of the discussion a series of two-dimensional (citer-cited) networks were produced. In a two-dimensional network, authors of the citing articles were the first dimensions, and the cited texts acted as their affiliations. A description of different two-dimensional networks is in Table 11. For example, it can be seen that 114 articles cited 218 articles, each of them having at least three citations, while the remaining five (119-114) articles may or may have not cited any of those 218.

Table 11 Number of citations, citing articles and cited texts

Number of citations	Number of citing articles	Number of cited texts
1	118	3855
2	117	525
3	114	218
4	108	103
5	105	66
6	103	50
7	101	38
8	96	28
9	93	21
10	91	17

Articles with very different sets of citations can be thought of as being out of the mainstream of a particular discussion. A threshold was used also to leave out references that do not have serious impact on this study, including articles depending heavily on individual statistical data and news articles. The literature does not suggest a unitary way to decide a particular threshold level. Ratnatunga and Romano (1997) believe that obtaining more than four citations would place an article into 'significant contribution' category, without comparing to the population size. Brown (1996) grouped the 'top 100 accounting articles' as 'classics', 'near classics' and 'other top

100'. In order to be a 'near classic', article had to be referenced three times, and 'a classic' had to be referenced four or more times. In this study, a different approach to selecting a threshold was selected. First, a limit of including 90% of citing articles was chosen. At this threshold (90,8 %), there were 108 articles citing 103 different texts, each being cited at least four times. The low threshold seems to capture the relevant articles, as some less relevant. Second, in order to validate the threshold, Table 11 was negotiated. It can be seen, that at the threshold of five citations (88,2 % of articles), the speed of decrease in numbers of cited papers flattens. This implies that threshold of five, or above, the marginal efficiency of leaving out cited articles diminishes. At that point, it is harder to separate many articles by increasing threshold only by one. As most of the discussants should be involved, it can be argued that the threshold should leave outside only those articles that are easily removed.

There were 11 citing articles that were left out after the process, and they did not seem to have a major influence on the discussion of network externalities. One of them did not have any citations, one article had only one citation, one article was a reply to other commentators, and two others discussed networks by relying to inter-personal facets of the problem. One article discussed intra-firm networks, and one was on inter-firm networks in country settings, which may have had implications to used citations. Four were economics papers, modelling international trade and foreign direct investments, pricing a network good, size of a firm, and foreign currency exchange, respectively. As these articles had three or less citations shared with other 108 articles, it can be argued that they do not follow the main stream of this discussion.

The articles were sorted alphabetically and given their new identification numbers. The third column gives information about how many times the article had been cited in the sample of 119 articles.

Table 12 Retrieved articles and the number of their citers

Original identification	New id	Number of citers
ADAMS WJ-Q REV ECON BUS-1982	1	4
ANDERSON P-ADM SCI Q-1990	2	8
ARROW KJ-REV ECON STUD-1962	3	4
ARTHUR WB-EC EVOLVING COMPLEX-1988	4	4
ARTHUR WB-ECON J-1989	5	19
ARTHUR WB-EUR J OPER RES-1987	6	6

ARTHUR WB-HARVARD BUS REV-1996	7	8
ARTHUR WB-INCREASING RETURNS P-1994	8	7
BANDURA A-SOCIAL LEARNING THEO-1977	9	4
BANERJEE AV-Q J ECON-1992	10	5
BARNEY JB-J MANAGE-1991	11	6
BARNEY JB-MANAGE SCI-1986	12	4
BASS FM-MANAGE SCI-1969	13	6
BAYUS BL-J PROD INNOVAT MANAG-1987	14	4
BEGGS AW-ECONOMETRICA-1992	15	7
BESEN SM-CHANGING RULES TECHN-1989	16	4
BESEN SM-COMPATIBILITY STANDA-1986	17	5
BESEN SM-J EC PERSP-1994	18	7
BIKHCHANDANI S-J POLIT ECON-1992	19	5
BRYNJOLFSSON E-MANAGE SCI-1996	20	14
BULOW JI-J POLIT ECON-1982	21	4
BULOW JI-J POLIT ECON-1985	22	4
BURNS LR-ACAD MANAGE J-1993	23	4
BURT RS-AM J SOCIOL-1987	24	7
CHOI JP-J IND ECON-1994	25	6
CHOI JP-RAND J ECON-1994	26	4
CHURCH J-J IND ECON-1992	27	6
CLARK KB-RES POLICY-1985	28	5
COASE RH-J LAW ECON-1972	29	4
COHEN WM-ADM SCI Q-1990	30	4
CONNER KR-MANAGE SCI-1991	31	4
CUSUMANO MA-BUS HIST REV-1992	32	5
DAVID PA-AM ECON REV-1985	33	30
DAVID PA-EC INNOVATION NEW TE-1990	34	7
DAVIS GF-ADM SCI Q-1991	35	5
DIMAGGIO PJ-AM SOCIOL REV-1983	36	6
ECONOMIDES N-AM ECON REV-1989	37	8
ECONOMIDES N-INT J IND ORGAN-1996	38	8
ELIASHBERG J-J MARKETING RES-1988	39	4
FARRELL J-AM ECON REV-1986	40	38
FARRELL J-ECON LETT-1986	41	7
FARRELL J-J IND ECON-1992	42	15
FARRELL J-PRODUCT STANDARDIZAT-1987	43	5
FARRELL J-Q J ECON-1988	44	7
FARRELL J-RAND J ECON NR 2-1988	45	7
FARRELL J-RAND J ECON-1985	46	45
FARRELL J-RAND J ECON-1988	47	5
FLAMM K-CREATING COMPUTER GO-1988	48	4
GABEL HL-COMPETITIVE STRATEGI-1991	49	4
GABEL HL-PRODUCT STANDARDIZAT-1987	50	9
GANDAL N-RAND J ECON-1994	51	13
GARUD R-STRATEGIC MANAGE J-1993	52	9
GILBERT RJ-J IND ECON-1992	53	4
GRANOVETTER M-AM J SOCIOL-1973	54	5
GRANOVETTER M-AM J SOCIOL-1978	55	6
GRANOVETTER M-AM J SOCIOL-1985	56	7
HENDERSON RM-ADM SCI Q-1990	57	8

HOTELLING H-ECON J-1929	58	4
KATZ ML-AM ECON REV-1985	59	57
KATZ ML-J EC PERSP-1994	60	16
KATZ ML-J IND ECON-1992	61	17
KATZ ML-J POLIT ECON-1986	62	53
KATZ ML-OXFORD ECON PAP-1986	63	10
KERIN RA-J MARKETING-1992	64	4
KLEMPERER P-Q J ECON-1987	65	6
LANGLOIS RN-BUS HIST REV-1992	66	4
LEIBENSTEIN H-Q J ECON-1950	67	6
LIEBERMAN MB-STRATEGIC MANAGE J-1988	68	6
MAHAJAN V-J MARKETING-1990	69	4
MALONE TW-COMMUN ACM-1987	70	4
MATUTES C-J IND ECON-1992	71	4
MATUTES C-RAND J ECON-1988	72	18
MEYER JW-AM J SOCIOL-1977	73	4
NELSON RR-EVOLUTIONARY THEORY-1982	74	9
NORTON JA-MANAGE SCI-1987	75	4
NUNNALLY JC-PSYCHOMETRIC THEORY-1978	76	4
OREN SS-BELL J ECON-1981	77	5
PADMANABHAN V-J MARKETING RES-1997	78	5
PORTER ME-COMPETITIVE STRATEGY-1980	79	9
REINGANUM JF-HDB IND ORG-1989	80	4
ROBERTSON TS-J MARKETING-1986	81	4
ROBERTSON TS-SLOAN MANAGE REV-1993	82	4
ROBINSON B-MANAGE SCI-1975	83	4
ROGERS EM-DIFFUSION INNOVATION-1962	84	15
ROHLFS J-BELL J ECON-1974	85	12
ROSENBERG N-INSIDE BLACK BOX TEC-1982	86	8
SALONER G-EC INNOVATION NEW TE-1990	87	4
SALONER G-RAND J ECON-1995	88	7
SALOP SC-BELL J ECON-1979	89	4
SHELLING TC-MICROMOTIVES MACRO-1978	90	5
SHAPIRO C-INFORMATION RULES-1999	91	5
SHURMER M-INFORMATION EC POLIC-1993	92	6
SPENCE AM-BELL J ECON-1981	93	6
TEECE DJ-RES POLICY-1986	94	10
TIROLE J-THEORY IND ORG-1988	95	8
TOLBERT PS-ADM SCI Q-1983	96	5
TUSHMAN ML-ADM SCI Q-1986	97	10
VONHIPPEL E-SOURCES INNOVATION-1988	98	4
WALDMAN M-Q J ECON-1993	99	5
WESTPHAL JD-ADM SCI Q-1997	100	4
WHINSTON MD-AM ECON REV-1990	101	4
WILLIAMSON OE-EC I CAPITALISM-1985	102	5
WILLIAMSON OE-MARKETS HIERARCHIES-1975	103	4

Two-dimensional citation data, or affiliation network, was exported to Ucinet 6 network analysis software for further analysis. A data matrix (119 articles, 103

references) was multiplied by its transpose for further analysis. A symmetric square matrix represented a co-citation profile for each of 103 articles (McCain, 1986). This procedure was also performed using Ucinet 6 software.

Co-citation data was normalised in order to produce a more realistic picture of discussion clusters. Using absolute counts would overemphasise the density of widespread articles whilst overlooking the proximity relations between similar, but quite rarely quoted references (Gmür, 2003). The normalised co-citations strength measure, *S*, for individual pairs was calculated by means of the Jaccard index (Small & Greenlee, 1980), also called co-citation strength. Using relative information has been found to produce sufficient differentiation, but it is not able to correct the tendency to overrate co-citations between commonly cited references (Gmür, 2003).

Table 13 Jaccard index

$$S = \frac{\text{co-citations of works A\&B}}{(\text{total citations of A} + \text{total citations of B} - \text{co-citations of A\&B})}$$

7.2 Details on clustering methods

Johnston's single-link, average-link, and complete link hierarchical algorithms, and Tabu cluster optimisation were tried in order to produce meaningful clusters. The results of different approaches are shown in the following paragraphs, as well as the procedure for producing Figure 3.

Tree-diagrams of clusters evidence how a single link method clusters articles one at a time, whilst the complete link method clusters in a compact manner. Positioned in the middle, the average link method produces clusters more continuously than the other hierarchical methods.

Johnston's hierarchical clustering finds a series of nested partitions of the items. The different partitions are ordered according to decreasing levels of similarity. The algorithm begins with the identity partition (in which all items are in different clusters). It then joins the most similar pair of items, which are then considered a single entity. The algorithm continues in this manner until all items have been joined into a single cluster (Borgatti, 2002).

The basis for selecting the method for further analysis lay in clustering efficiency. Tree-diagrams of clusters evidence how single link and complete link methods cluster articles individually or respectively in a compact manner. On the other hand, average link produced clusters more continuously than the other hierarchical methods. For these reasons, average link was used as a method for further analysis. Cluster optimisation is not a method often used in bibliometric research, because the number of theoretically optimum number of clusters is not known. In this study it was tried for comparison of results. Using different methods provides more reliable clusters, if the results remain similar.

Major clusters in the network externalities discussion were found with all different methods. For example, the core articles establishing the field, or the discussion appear in the same clusters. Some clusters are not as distinctive, and some overlap between clusters exists.

Hierarchical methods have no generally accepted rules for selecting the best set of clusters to report (McCain, 1990). The tree-diagrams are often used to visualise the information on structure. The cases are on X-axes and Y-axis gives information on the value of similarity among articles. The maximum value for similarity is 1. The number of clusters diminishes moving down on Y-axis, describing the process of individual articles and smaller clusters joining together.

In the average distance algorithm distance between two clusters is the average dissimilarity between members (Borgatti, 2002). At higher levels of similarity, more clusters emerge, until the 'branches' reaches the level of individual articles. The average-link illustrates both the most separated clusters, as single-link, and also less distinctive clusters, see Figure 13. Due to space restrictions, the similarity values, and identification numbers are not observable in the dendrogram. The tree has eight branch-like departures at similarity level 0.067. These clusters are separated with a thicker line. At the left there are also two individual articles (ID numbers 98 and 49) falling out of these clusters. These clusters with their respected article identification numbers are in Table 14. At higher levels of similarity, more clusters emerge, until the 'branches' reaches the level of individual articles.

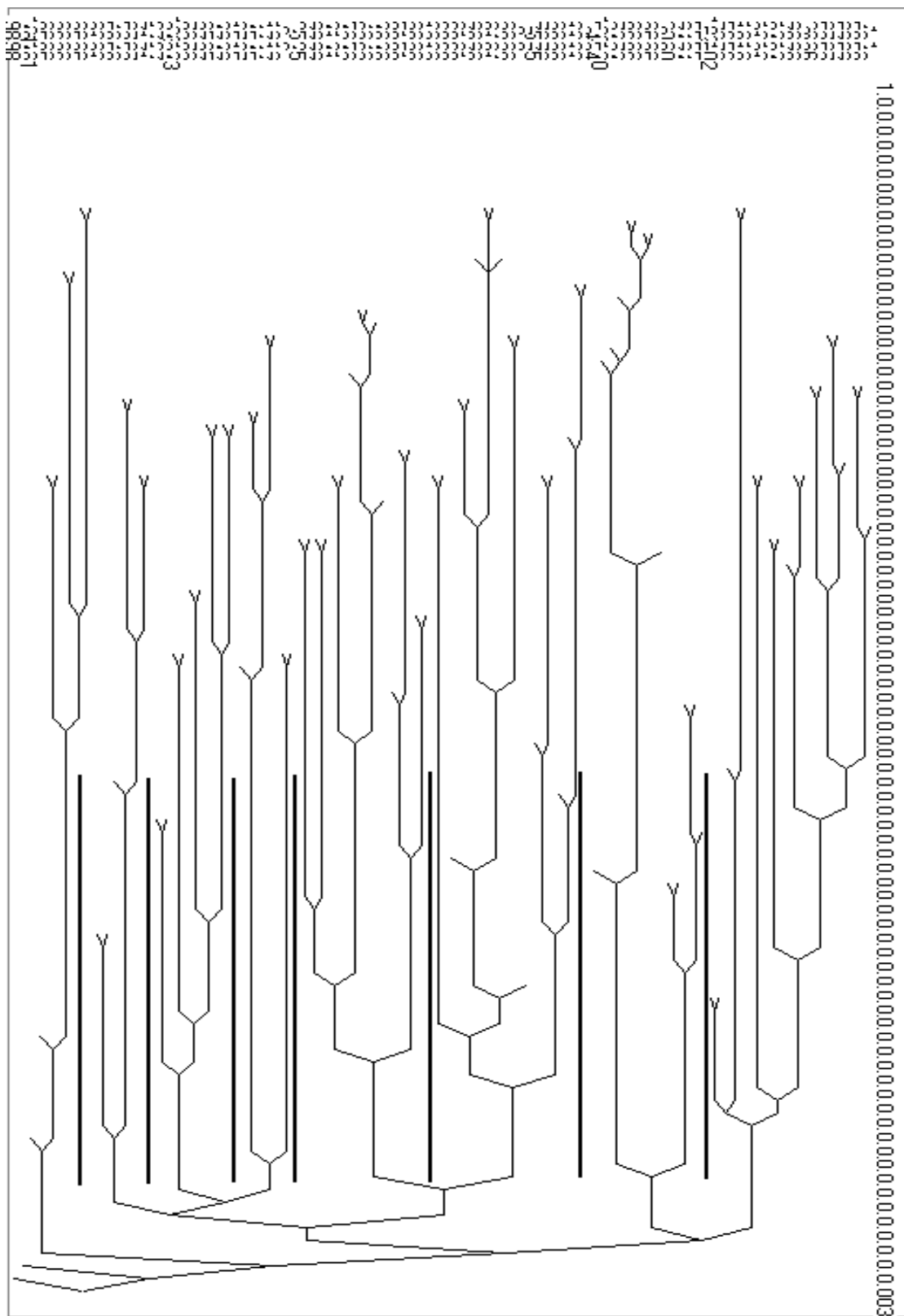


Figure 13 Average link cluster tree diagram

The cluster identification follows the division sketched out in Table 14 starting from left, with the exception that the two documents in the bottom-left corner are left out.

The first emerging sub-clusters, which were larger than two in size, were also identified. They appear approximately at similarity level of 0.07-0.01.

Table 14 Major average link clusters and the first sub-clusters

A		101, 95, 80, 26, 99, 25, 29, 21
B		89, 58, 43, 53, 27, 71, 14
C		67, 34, 103, 93, 72, 37, 65, 47, 22, 15
D		87, 45, 44, 17, 16, 6, 4
E	E.i	85, 77, 63, 41, 61, 42, 59, 62, 46, 40, 33
	E.ii	88, 51, 20, 38, 13
F	F.i	83, 69, 60, 91, 78, 82, 81, 64, 39, 32, 8, 7
	F.ii	75, 76, 30, 92, 11, 68, 2
G	G.i	54, 100, 24, 73, 96, 36, 35, 23, 9
	G.ii	90, 74, 84, 55, 5
H	H.i	102, 70, 56, 19, 10,
	H.ii	31, 12, 94, 18, 79, 86, 3, 66, 52, 97, 57, 28, 50, 48, 1

In the complete link, the distance between two clusters is defined by as largest dissimilarity between members (Borgatti, 2002). Jain et al. (1999) reviewed clustering methods, and reiterated that the algorithm produces tightly bound or compact clusters, which are quite useful to work with (Jain et al., 1999). With this data complete link algorithm produced either 1, 19, or even more clusters, which seems unpractical for the study. In the single link method the distance between two clusters is the smallest dissimilarity between the members (Borgatti, 2002). The results of the single link algorithm make it difficult to choose one level for clustering consisting of most of the articles. A review of Jain et al. (1999) evaluated the earlier idea that single the algorithm has a tendency to produce clusters that are straggly or elongated, a view further supported by this data. The algorithm separates the discussion participants rapidly, but almost individually. The tree-diagram has the look of a bush bent by a strong wind, and the figure does not suggest one clear cut-off point. Researchers have to choose a particular level for detailed analysis, referring to higher or lower levels when useful (McCain, 1990). In Figure 14, there are three separate thicker branches (4 or more members at or above similarity value of 0.429), which may suggest to different research discussions. The clusters, with their respected article identification numbers are in Figure 14. Note, that the alphabetical coding is different when using different algorithms. The ordering follows their appearance in the computer printout.

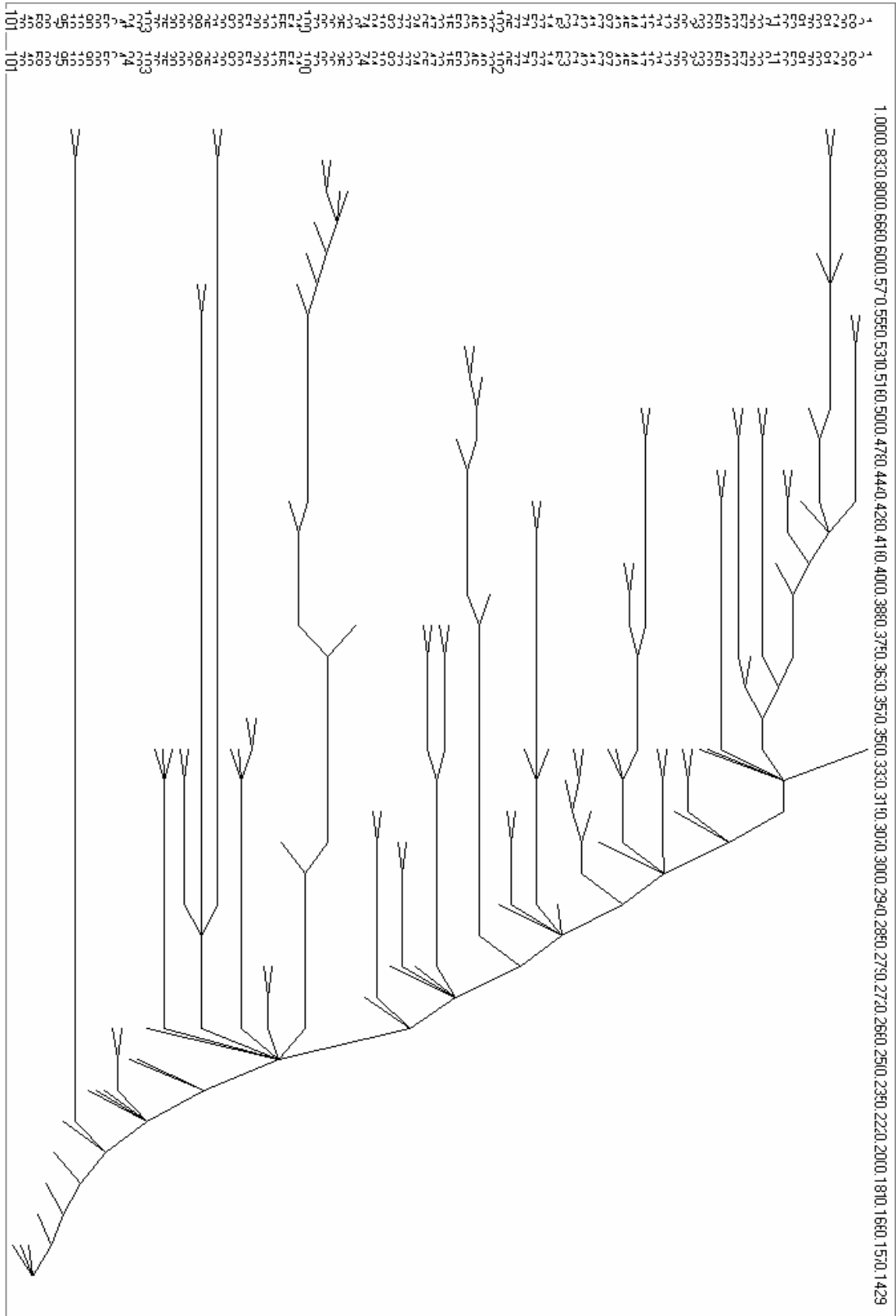


Figure 14 Single-link tree diagram

Table 15 Major single-link clusters

A.	73, 23, 35, 36, 96, 100
B.	59, 40, 62, 46
C.	66, 52, 91, 78, 82, 81, 64, 39, 68, 2

Cluster B in the single-link output is the core of the network externality discussion. The documents have similar citing patterns, which is partly because they were written in a short period of time (1985-1986) by two writing teams. This core of network externalities articles is widely shared by most of the later writers joining the discussion. The authors laid the foundation for most of the others, which is the distinctive feature of this cluster.

A comparison of the three clustering methods (average link, single link and complete clustering methods) revealed the strong position of some of the core documents. The cut-off point of similarity for choosing the single-link clusters was higher in the scale compared to other methods. Therefore, the members of single-link clusters should be found with the other methods using lower cut-off point. Members of the single-link cluster A (73, 23, 35, 36, 96, 100) are members of average link cluster G.i, and Tabu 8 cluster E. Members of the single-link cluster b (59, 40, 62, 46) are members of average link cluster E.i and Tabu 8 cluster C. Single-link cluster C members (82, 81, 64, 39) belong also to the groups of average link cluster F.i and Tabu 8 cluster A.

Table 16 Strong overlap of different clusters

Cluster method and identification	Document number	Cluster method and identification	Document number	Cluster method and identification	Document number
Single link A	73, 23, 35, 36, 96, 100	Average link cluster G.i	54, 100, 24, 73, 96, 36, 35, 23, 9	Tabu 8 cluster E	9, 10, 19, 23, 24, 35, 36, 54, 55, 56, 73, 90, 96, 100
Single-link cluster B	59, 40, 62, 46	Average link cluster E.i	85, 77, 63, 41, 61, 42, 59, 62, 46, 40, 33	Tabu 8 cluster C	13, 20, 33, 38, 40, 46, 51, 59, 60, 61, 62, 63, 84, 85, 88
Single-link cluster C	82, 81, 64, 39	Average link cluster F.i	83, 13, 69, 60, 91, 78, 82, 81, 64, 39, 32, 8, 7	Tabu 8 cluster A	8, 18, 27, 32, 39, 53, 64, 75, 76, 78, 81, 82, 83, 91, 92

There is a weaker, but noticeable similarity between wider groups of average-link cluster A, and Tabu 8 cluster D, between average-link cluster E, and Tabu 8 cluster C, between average-link cluster F, and Tabu 8 cluster A, between average-link cluster G and Tabu 8 cluster E, between average-link cluster H and Tabu 8 cluster F.

Table 17 Weaker similarity of different clusters

Cluster method and identification	Document number	Cluster method and identification	Document number
Average link cluster A	101, 95, 80, 26, 99, 25, 29, 21	Tabu 8 cluster D	21, 25, 26, 29, 69, 77, 80, 95, 99, 101
Average link cluster E	85, 77, 63, 41, 61, 42, 59, 62, 46, 40, 33, 88, 51, 20, 38, 13	Tabu 8 cluster C	13, 20, 33, 38, 40, 46, 51, 59, 60, 61, 62, 63, 84, 85, 88
Average link cluster F	83, 69, 60, 91, 78, 82, 81, 64, 39, 32, 8, 7, 75, 76, 30, 92, 11, 68, 2	Tabu 8 cluster A	8, 18, 27, 32, 39, 53, 64, 75, 76, 78, 81, 82, 83, 91, 92
Average link cluster G	54, 100, 24, 73, 96, 36, 35, 23, 9, 90, 74, 84, 55, 5	Tabu 8 cluster E	9, 10, 19, 23, 24, 35, 36, 54, 55, 56, 73, 90, 96, 100
Average link cluster H	102, 70, 56, 19, 10, 31, 12, 94, 18, 79, 86, 3, 66, 52, 97, 57, 28, 50, 48, 1	Tabu 8 cluster F	1, 3, 4, 28, 48, 50, 57, 66, 70, 79, 86, 97, 102

The rest of the clusters did not have such clear counterparts when using different algorithms, which leads to the suggestion that cluster instability may be a sign of some overlapping, or thin clusters.

In order to spread out the visible structure of the discussion, data had to be normalised for Figure 3. In order to make reading it easier, I reduced the number of visible links by having an arbitrary cut-off level of co-citation strength. Those links below the cut-off level were left out of the picture, as well as articles isolated by this procedure. In the graph, the remaining links and articles visually indicate which documents may act as a bridge from one stream of discussion to another. The differences in the visual structure and in the clusters described previously are due to the differences in the method. Normalised co-citation data and Ucinet Netdraw program was used for this purpose. An arbitrary cut-off for co-citation strength of 0.25 was used to isolate documents with less in common with others. Netdraw program arranged the remaining documents according to geodesic distances. With this cut-off point, the groups are linked to each other, but their distinctiveness can be observed. The isolates are left from the picture. Some positions have been slightly changed for the visual

presentation to make the document identification number observable. Groups A and B share a legend because of the limitation of the used software.

Cluster E includes the classic network externalities is located inside the group containing clusters A to D. The two other groups showing stability irrespective of the clustering method, namely F and G, are clearly traceable from the picture. Still even with the cohesiveness, some major members of cluster G are detached from their cluster neighbours.

7.3 Details on using social network analysis with bibliometric data

Bibliometric methods rely on several measures borrowed from social network analysis (Oliver & Ebers, 1998; Phillips & Phillips, 1998; Parvinen, 2003). In the co-citation context, the amount of information in the link is the number of co-citations. If there are only few citers, the links emerge as weak. Individual researchers referencing non-equivalent documents may have made these weak links. As the number of co-citations grows, the role of non-equivalent citations also diminishes, because stronger links imply more evident co-citation patterns. Therefore, social network measures are more reliable when the links and nodes are stronger.

There are a variety of social network measures used to signify the differences in bibliometric data. Centrality in the co-citation context can be operationalized as the number of direct ties of a cited author, omitting the indirect paths. The assumption of the betweenness centrality measure is that information is passed from one node to another along the shortest, or otherwise most proximate path linking them (Freeman et al., 1991). Betweenness measures are used to capture the bridging ability of individual points (Freeman, 1977, 1979; Freeman et al., 1991). If a node does not have any ties, it does not have a channel to carry its information forward (Freeman et al., 1991). A point of high betweenness value has the possibility to facilitate or limit the interaction between the nodes of its linked points (Freeman, 1979). Betweenness centrality based on maximum flow of information considers links connecting points as having different capacities for passing information. Freeman's betweenness centrality cannot use information on different strength of links i.e. either a link exists or it does not (Freeman, 1977).

Freeman's betweenness centrality (Freeman, 1977) is often used to analyse how theoretical constructs are passed along in the scientific discourse (e.g. Oliver & Ebers, 1998; Phillips & Phillips, 1998; Parvinen, 2003). The measure calculates the shortest possible path along two points, which does not take in account different routes (Stephenson & Zelen, 1989; Freeman et al., 1991; Wasserman & Faust, 1994). In many occasions the link may have different values. The flow measure does not consider direct links as being more efficient than indirect (Freeman et al., 1991).

If there are two information sources (s_1, s_2), the citers may link information directly or indirectly. In the latter, all the other possible channels and passing nodes connecting the two could be included (Freeman et al., 1991). Connections between s_1 and s_2 , and s_2 and s_3 , and s_3 and s_4 are usually manipulated to draw a path $s_1-s_2-s_3-s_4$. However, without knowledge of the quality of cites, one cannot conclude that there is a certain kind of path. The purpose for choosing particular co-citations may differ from one pair to another. The betweenness measure is understood in this co-citation context to be the maximum possibility that bringing a node s_x to the path interferes or converts information (possibly) shared by the s_{x-1} and s_{x+1} . The writer of s_x has not necessarily written her article to link it with its neighbours, as it is the citers who have done the linkage by co-citing them. As the neighbours, s_{x-1} and s_{x+1} , are not directly linked, the shared information may be covert in nature.

It can be argued that the number of co-citations represents the information potential of a link, and not the actual flow of information. Stephenson and Zelen (1989) propose that information flow should also take account of path length. To remedy the problem of long and diverse information paths, I use Stephenson and Zelen's information centrality measure (1989). Each path is weighted in proportion to its information, and the paths are then combined. Information centrality indicates the maximum information each node then has after combining of all the paths (Stephenson & Zelen, 1989). A high value in information centrality tends to imply a large number of short paths to many others within the network. Information centrality is calculated from all the paths going through all the possible nodes. 'Noise' in a signal is measured by variance. Information loss occurs each time there is a new link. If the variance of one link is unity, the variance counts the number of links along the path i.e. path length. The amount of information is reciprocal to the variance. Each path is weighed

proportional to its information, and the paths are combined. Information centrality indicates the maximum information each node has after combination of all the paths (Stephenson & Zelen, 1989). High value in information centrality tends to implicate large number of short paths to many others within network.

High betweenness centrality does not necessarily mean that the node lies in the core, but may indicate that a cited document connects diverse streams of discourse (Borgatti & Everett, 1999). In the case of an emerging synthesis of different streams, a citer reveals some covert shared basis of different streams. If proved useful, the citer herself becomes the cited, because the cited article will be trespassed. If followers will take a similar stance on synthesising, the differing streams are directly connected. New citers will link the documents representing the differing streams. The significance of bridge-like connections evaporates, when links become denser. A bibliometrical mapping is an interim result of a discussion, not a final one.

In this work, betweenness is a measure the maximum likelihood that a node s_x interferes or converts information potentially shared by the s_{x-1} and s_{x+1} . Betweenness is therefore a capacity, not necessarily fulfilled. Betweenness measures were calculated for Stephenson and Zelen information centrality (Stephenson & Zelen, 1989), and more conventionally Freeman's betweenness centrality. As point of analysis was on node's capacity to facilitate information flows, a co-citation data was used without standardisation. Ucinet 6 binarised data for calculating Freeman's betweenness centralities. Diagonal values of matrices were omitted for Stephenson and Zelen information centrality.

The mean of citers in 103 documents is 8.3. Values for Freeman centrality betweenness range from nil to 252.92, with a mean of 29.56. Values for Stephenson and Zelen information centrality start from 9.98 ending in 50.91, with mean of 30.59. One document has the highest score in every index. All the documents scoring above the mean in Freeman centrality (with one exception ID 27)) and all documents above mean in the number of citers, score above mean in information centrality. The documents having a score above the mean in any of the indexes are included in

Table 18 Document centralities. No documents in cluster A reached mean scores. In the table, also a cluster, and sub-cluster description is given. Documents having betweenness centrality values over the mean are marked in bolded characters. With clusters E, F, and H, there is a sub-heading in the cluster description to reflect the division in the cluster.

Table 18 Document centralities

Document ID	Cluster ID	Cluster description (sub-cluster description after colon)	Between-ness	Information	Number of citers
98	No cluster		0	9,98	4
49	No cluster		3,52	18,80	4
21	A	Economics: Firm innovation and strategic interaction	0,82	18,45	4
29	A		0,82	18,45	4
101	A		1,35	14,84	4
99	A		3,59	24,23	5
80	A		3,62	20,00	4
25	A		14,38	30,08	6
95	A		15,74	27,57	8
26	A		23,76	28,88	4
89	B	Economics: Compatibility and standardisation	1,44	19,65	4
14	B		2,72	25,97	4
58	B		2,77	17,88	4
53	B		10,67	28,88	4
71	B		12,38	30,03	4
43	B		13,89	29,77	5
27	B		45,81	35,54	6
22	C	Economics: Systems vs. components	7,22	25,06	4
47	C		7,70	29,92	5
67	C		9,69	28,38	6
37	C		14,36	32,52	8
93	C		16,60	29,10	6
15	C		16,74	33,02	7
103	C		19,13	27,94	4
65	C		25,69	32,06	6
34	C		49,18	35,98	7
72	C		70,94	42,89	18
4	D	Economics: Switching costs and market structure	3,61	22,02	4
6	D		3,63	22,39	6
87	D		3,95	25,05	4
16	D		5,48	26,48	4
17	D		9,39	30,38	5
44	D		14,96	35,13	7
45	D		19,00	33,97	7
77	E.i	Network externalities: Core Concepts	5,84	23,11	5
13	E.ii	Network externalities: Empirical context	6,83	30,62	6
88	E.ii		7,27	29,52	7
38	E.ii		7,49	29,27	8
41	E		26,18	36,03	7
20	E.ii		27,75	39,49	14
63	E.i		39,51	39,25	10
51	E.ii		45,45	40,28	13
85	E.i		55,39	40,60	12
61	E.i		64,94	43,70	17

42	E.i		79,44	42,95	15
33	E.i		175,77	47,05	30
40	E.i		190,35	49,21	38
62	E.i		208,49	50,33	53
46	E.i		208,73	49,73	45
59	E.i		252,92	50,91	57
75	F.i	Path dependence: Firms and industries	2,41	22,41	4
69	F.ii	Path dependence: Technology diffusion and market structure	2,83	23,81	4
83	F.i		4,38	29,54	4
39	F.i		6,62	33,37	4
82	F.i		6,79	31,02	4
30	F.ii		7,99	25,36	4
76	F.ii		8,10	25,38	4
91	F.i		8,54	30,40	5
64	F.i		9,58	33,19	4
81	F.i		9,58	33,19	4
32	F.i		10,88	31,44	5
78	F.i		15,93	35,34	5
8	F.i		17,55	36,75	7
7	F.i		22,57	30,89	8
68	F.ii		24,46	36,89	6
92	F.ii		24,83	33,61	6
2	F.ii		29,77	38,30	8
11	F.ii		46,57	32,02	6
60	F.i		116,93	42,89	16
100	G.i	Collective action: Interaction of individual with social structure	0,19	15,63	4
23	G.i	Collective action: Market structure	3,16	23,17	4
35	G.i		3,16	23,76	5
90	G.ii		4,61	22,74	5
54	G.i		7,57	21,29	5
73	G.i		10,25	26,04	4
96	G.i		13,39	26,84	5
24	G.i		14,16	28,11	7
9	G.i		16,31	23,58	4
36	G.i		20,45	30,41	6
55	G.ii		31,59	32,05	6
74	G.ii		39,11	33,10	9
84	G.ii		106,52	43,06	15
5	G.ii		114,16	44,12	19
70	H.i	Decision making: Social structure's effect on decision making	5,90	18,80	4
66	H.ii	Decision making: Structure's effect on firm strategy	5,97	26,18	4
48	H.ii		6,01	26,74	4
12	H.ii		6,41	25,68	4
31	H.ii		6,94	25,39	4
102	H.i		7,11	22,01	5

10	H.i		8,18	21,37	5
19	H.i		8,18	21,37	5
3	H.ii		9,45	25,09	4
1	H.ii		10,51	26,24	4
28	H.ii		13,99	30,57	5
57	H.ii		16,76	33,97	8
56	H.i		17,03	30,12	7
50	H.ii		20,97	36,69	9
18	H.ii		32,72	35,82	7
52	H.ii		34,64	39,04	9
86	H.ii		45,91	36,20	8
94	H.ii		49,86	38,95	10
79	H.ii		55,00	38,49	9
97	H.ii		65,61	39,09	10

The following table offers information about the most influential documents in the clusters produced by the average link method. Bolded article identification numbers indicate that the article is influential. It can be seen that the original cluster A does not have any articles with centrality above the mean, and clusters B and D offer only one or two important articles.

Table 19 Average link clusters with their cluster description and most influential documents

Cluster	Sub-cluster	Article ID	Cluster description, and most influential documents in the cluster
A		101, 95, 80, 26, 99, 25, 29, 21	Economics: Firm innovation and strategic interaction Tirole(1988): Theory of Industrial Organisation J.P.Choi: (1994) Network Externality, Compatability Choice, and Planned Obsolence
B		89, 58, 43, 53, 27 , 71, 14	Economics: Compatibility and standardisation Church and Gandal (1992): Network effects, software provision, and standardisation
C		67, 34 , 103, 93, 72 , 37 , 65 , 47, 22, 15	Economics: Systems vs. components Matutes and Regibeau (1988): Mix and Match – Product compatibility without network externalities.
D		87, 45 , 44 , 17, 16, 6, 4	Economics: Switching costs and market structure Farrell and Shapiro (1988): Dynamic Competition with Switching Costs Farrell and Gallini (1988): Second-sourcing as a commitment – monopoly incentives to attract competition
E	E.i	85 , 77, 63 , 41 , 61 , 42 , 59 , 62 , 46 , 40 , 33	Network externalities: Core concepts Farrell and Saloner (1985): Standardisation, Compatibility, and Innovation and Farrell and Saloner (1986): Installed Base and Compatibility – Innovation, Product Preannouncements Predation Katz and Shapiro (1986):

			Technology Adoption in the Presence of Network Externalities Katz and Shapiro (1985): Network Externalities, Competition, and Compatibility
	E.ii	88, 51 , 20 , 38, 13	Network externalities: Empirical context Gandal (1994): Hedonic Price Indexes for Spreadsheets and an Empirical Test for Network Externalities
F	F.i	83, 69, 60 , 91, 78 , 82 , 81 , 64 , 39 , 32 , 8 , 7	Path dependence: Technology diffusion and market structure Katz and Shapiro (1994): Systems competition and Network Effects
	F.ii	75, 76, 30, 92 , 11 , 68 , 2	Path dependence: Firms and industries Anderson and Tushman (1990): Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change Lieberman and Montgomery, (1988): First-Mover Advantages Barney (1991): Firm resources and Sustained Competitive Advantage
G	G.i	54, 100, 24, 73, 96, 36, 35, 23, 9	Collective action: Interaction of individual with social structure DiMaggio and More (1993): Cultural Capital, Educational Attainment, and Marital Selection
	G.ii	90, 74 , 84 , 55 , 5	Collective action: Collective action and market structure Arthur (1989): Competing Technologies, Increasing Returns, and Lock-in by Historical Events Rogers (1962): Diffusion of Innovations Nelson and Winter (1982): Evolutionary Theory
H	H.i	102, 70, 56, 19, 10	Decision making: Social structure's effect on decision making Granovetter (1985): Economic Action and Social Structure: The Problem of Embeddedness
	H.ii	31, 12, 94 , 18 , 79 , 86 , 3, 66, 52 , 97 , 57 , 28, 50 , 48, 1	Decision making: Structure's effect on firm strategy Tushman and Anderson (1986): Technological Discontinuities and Organisational Environments Porter (1980): Competitive Strategy Teece (1986): Profiting from Technological Innovation – Implications for Integration, Collaboration, Licensing and Public-Policy Rosenberg (1982): Inside the Black Box: Technology and Economics

7.4 The 1998-2003 citer articles published in selected business journals

The most important citer articles published in recent business strategy journals were negotiated. For this purpose, the two-dimensional citer-cited network used for the clustering was again used, but this time for retrieving information on the citer articles. To be considered as important recent article, the document had to be published during 1998-2003 in a 20 most influential business strategy journals, according to the ISI

Journal Report 2002 impact factor loadings. Twelve articles were retrieved, which were themselves cited at least once in addition to possible first-author self-citations.

Table 20 Recent citer research on network externality

Author(s)	Article name	Journal
Yannis Bakos; Erik Brynjolfsson	Bundling and Competition on the Internet	Marketing Science, Vol. 19, Issue 1, Special Issue on Marketing Science and the Internet. Winter, 2000, pp. 63-82.
Hemant K. Bhargava, Vidyanand Choudhary, and Ramayya Krishnan	Pricing and Product Design: Intermediary Strategies in an Electronic Market	International Journal of Electronic Commerce, Volume 5, Issue 1, Fall 2000, pp. 37.
Dekimpe MG, Parker PM, Sarvary M	Global diffusion of technological innovations: A coupled-hazard approach	Journal of Marketing Research, Vol. 37 Issue 1 February 2000 pp. 47-59
Sachin Gupta; Dipak C. Jain; Mohanbir S. Sawhney	Modeling the Evolution of Markets with Indirect Network Externalities: An Application to Digital Television	Marketing Science, Vol. 18, Issue 3, Special Issue on Managerial Decision Making, 1999, pp. 396-416.
Hellofs LL, Jacobson R	Market share and customers' perceptions of quality: When can firms grow their way to higher versus lower quality?	Journal of Marketing Vol.63 Issue 1, 1999 pp.16-25
Leo van Hove	The New York City Smart Card Trial in Perspective: A Research Note	International Journal of Electronic Commerce, Volume 5, Issue 2, Winter 2000-2001, pp. 119.
Robert J. Kauffman and Eric A. Walden	Economics and Electronic Commerce: Survey and Directions for Research	International Journal of Electronic Commerce, Volume 5, Issue 4, Summer 2001, pp. 5.-
Majumdar SK, Venkataraman S..	Network effects and the adoption of new technology: Evidence from the US telecommunications industry.	Strategic Management Journal 19 Issue 11, 1998, pp. 1045-1062
Melissa A. Schilling	Technological Lockout: An Integrative Model of the Economic and Strategic Factors Driving Technology Success and Failure	The Academy of Management Review, Vol. 23, Issue 2, Apr., 1998, pp. 267-284.
Melissa A Schilling.	Technology success and failure in winner-take-all markets: The impact of learning orientation, timing, and network externalities	Academy of Management Journal. Briarcliff Manor: Apr 2002. Vol. 45, Issue. 2; p. 387
Stoughton NM, Wong KP, Zechner J	IPOs and product quality	Journal of Business Vol. 74 Issue 3, July 2001, pp. 375-408
Young GJ, Charns MP, Shortell SM	Top manager and network effects on the adoption of innovative management practices: A study of TQM in a public hospital system	Strategic Management Journal Vol. 22 Issue 10, October 2001, pp. 935-951

7.5 Details on firm strategy and organisational research bibliometric study

The documents that surfaced in the first conducted bibliometric study on network externality were used as ‘seed’ documents. Many of the important documents can be associated with discourses other than the field of network externalities. These documents act here as a proxy for a scientific field. The subjectively chosen documents are in Table 21 with their descriptions. The most cited article in the network externality discussion, Katz and Shapiro (1985), represents the network externality discussion. Choosing one article instead of a key word is based on an assumption of a citation as a symbol of an idea (Small, 1978).

Table 21 Related fields and their representative documents

Approach/framework	Representative document	Citers in 1999-2003	Citers in 2003
Diffusion theories	Rogers (1995): Diffusion of Innovations	680	223
Resource-based view	Barney (1991): Firm resources and Sustained Competitive Advantage	740	185
Evolutionary approach	Nelson and Winter (1982): Evolutionary Theory	624	183
Social structures	Granovetter (1985): Economic Action and Social Structure: The Problem of Embeddedness	749	179
Industrial organisation	Porter (1980): Competitive Strategy	580	114
Network externalities	Katz and Shapiro (1985): Network Externalities, Competition, and Compatibility	202	58
Dominant designs	Tushman and Anderson (1986): Technological Discontinuities and Organisational Environments	252	57
Complex, evolving systems	Arthur (1989): Competing Technologies, Increasing Returns, and Lock-in by Historical Events	245	48
First-mover advantage	Lieberman and Montgomery (1988): First-Mover Advantages	141	27

The field of economics covers network externalities, and the number of relevant publications is large. To shed more light on societal views and to serve the realm of

strategic management, I used only one of the core documents representing the field of economics, that from Katz and Shapiro (1985).

As the aim was to locate the network externalities discussion into larger context, all of the journals in the ISI Web of Science Social Science Index were used for data mining. A search was made to find all articles citing the mentioned 'seed' article that were published in 2003. The one-year time window was due to computer resources, but it also helps to draw a map of the current discourse. The new articles with all of their references (including seeds) were retrieved. This produced 36772 cited documents in 893 different articles.

The large sample has different requirements than the network externalities discourse bibliometric study. More citations allow an investigator to put more trust in the reliability of citations. If the percentage of erroneous filings is the same, the greater number of citations ensures easier analysis of data. In addition, a large quantity of data would make the efforts more difficult to uniformly correct e.g. misspellings.

An arbitrary cut-off for co-citation strength of 0.1 was used to isolate documents with less in common with others. The analysed matrix was 885 articles, which referenced 53 documents. The Netdraw program was used to arrange the remaining documents according to geodesic distances, seen in Figure 1. The Ucinet Netdraw program used normalised co-citation data.

At this threshold level, the most popular citation, 'Diffusion of Innovation' by Everett Rogers (number 42 in this graph) is an isolate, because of the seemingly varied citation patterns of its citers. Although the series of editions by Rogers are very popular, it has been cited in different contexts. Compared to the others, it has been a source for more varied reasons, and therefore, it is not strongly associated with other documents.

The problems of different ways of indexing data was solved by choosing the most common reference, e.g. Porter (1980) Competitive Strategy was spelled in different ways, from which the most popular one was chosen. The timeframe for mapping is 2003 in order to posit different approaches in recent discussion. The number of citers allows positioning, while a greater data corpus would make the analysis difficult for

normal computers. The most recent document is published in 1991, so all of the chosen documents have been available for researcher during the studied time frame. Rogers' 'Diffusion of Innovations' edition from 1995 was chosen, as it was the last in the chosen timeframe.

There were 893 articles referencing at least one of the above. Those articles referenced altogether 36772 differently coded texts. The threshold was set to 27 as it was the number of citers the article Lieberman and Montgomery (1988) received. This produced a network of 885 articles referencing to 55 documents. As Penrose (1958) and Nelson (1982) had ambiguous surname coding, their contributions were checked from the original material. This produced a new matrix, where the two very distinguished documents received more citing. The size of the matrix was 885 articles referencing to 53 documents.

Even with time frame set in ISI Web of Science, the ISI produced some data from 2002, and 2004, which had to be left out. Finally, there were 53-9=44 publicised documents found from the database. In Table 22 are the names of the retrieved documents with the number of citers, and document identification corresponding to Table 22. It has to be noted that the corrections produced the observable differences between numbers of citers some the influential articles have received (Table 21 and Table 22).

Table 22 Cited documents with the number of citers

	Citers	Document ID
AMIT R-STRATEGIC MANAGE J-1993	42	1
ARTHUR WB-ECON J-1989	51	2
BARNEY J-J MANAGE-1991	186	3
BARNEY JB-MANAGE SCI-1986	35	4
COASE RH-ECONOMICA-1937	28	5
COHEN WM-ADMIN SCI QUART-1990	82	6
COLEMAN JS-AM J SOCIOLOG-1988	33	7
CYERT RM-BEHAV THEORY FIRM-1963	46	8
DAVID PA-AM ECON REV-1985	35	9
DIERICKX I-MANAGE SCI-1989	58	10
DIMAGGIO PJ-AM SOCIOLOG REV-1983	45	11
DOSI G-RES POLICY-1982	27	12
EISENHARDT KM-ACAD MANAGE REV-1989	40	13
EISENHARDT KM-STRATEGIC MANAGE J-2000	28	14
GRANOVETTER M-AM J SOCIOLOG-1985	185	15
GRANOVETTER MS-AM J SOCIOLOG-1973	45	16
GRANT RM-CALIF MANAGE REV-1991	31	17

GRANT RM-STRATEGIC MANAGE J-1996	31	18
HANNAN MT-AM SOCIOL REV-1984	30	19
HANNAN MT-ORG ECOLOGY-1989	29	20
HENDERSON RM-ADMIN SCI QUART-1990	50	21
HUBER GP-ORGAN SCI-1991	28	22
JENSEN MC-J FINANC ECON-1976	31	23
KATZ ML-AM ECON REV-1985	60	24
KOGUT B-ORGAN SCI-1992	50	25
LEONARDBARTON D-STRATEGIC MANAGE J-1992	37	26
LEVITT B-ANNU REV SOCIOL-1988	35	27
LIEBERMAN MB-STRATEGIC MANAGEMENT-1988	27	28
LIPPMAN SA-BELL J ECON-1982	28	29
MARCH JG-ORGAN SCI-1991	45	30
MARCH JG-ORGANISATIONS-1958	37	31
MEYER JW-AM J SOCIOL-1977	38	32
NELSON RR-EVOLUTIONARY THEORY-1982	220	33
NONAKA I-KNOWLEDGE CREATING C-1995	41	34
NONAKA I-ORGAN SCI-1994	39	35
PENROSE ET-THEORY GROWTH FIRM-1959	63	36
PETERAF MA-STRATEGIC MANAGE J-1993	43	37
PFEFFER J-EXTERNAL CONTROL ORG-1978	46	38
PORTER ME-COMPETITIVE ADVANTAG-1985	36	39
PORTER ME-COMPETITIVE STRATEGY-1980	114	40
PRAHALAD CK-HARVARD BUS REV-1990	50	41
ROGERS EM-DIFFUSION INNOVATION-1995	224	42
RUMELT RP-STRATEGIC MANAGE J-1991	27	43
SCHUMPETER JA-THEORY EC DEV-1934	28	44
TEECE DJ-RES POLICY-1986	30	45
TEECE DJ-STRATEGIC MANAGE J-1997	77	46
TUSHMAN ML-ADMIN SCI QUART-1986	57	47
UZZI B-ADMIN SCI QUART-1997	31	48
UZZI B-AM SOCIOL REV-1996	30	49
VONHIPPEL E-SOURCES INNOVATION-1988	27	50
WERNERFELT B-STRATEGIC MANAGE J-1984	88	51
WILLIAMSON OE-EC I CAPITALISM-1985	40	52
WILLIAMSON OE-MARKETS HIERARCHIES-1975	39	53

7.6 Case study data sources

A formal case study protocol was not produced in the beginning of the research, as the research strategy was selected during the course of the study. The iterative process of delivering research plans raised some of the same topics as a case study protocol (Yin 2003). These include an introduction to the case study, data collection procedures, and case study questions. An outline of the case study report was given by the academic requirements.

A formal case study protocol concerning case study questions and field procedures was written in the course of research, well before interviews. The case protocol used for the interviews follows.

7.6.1 Case protocol

7.6.1.1 Role of protocol in guiding the case study investigator

A protocol is a standardised agenda for conducting the inquiry. In this study, the standardisation is part of preparation for the interviews.

7.6.1.2 Data collection procedures

Interviewed persons, their affiliations to the question, and the site to be visited

Type of visit	Person	Date
Pre-arranged meetings	Dame Patricia Hodgson	30.11.2004
	Allan Williams	3.12.2004
	Julian McCougan	6.12.2004
	Michael Starks	8.12.2004
Meetings arranged during the trip	Professor emeritus Vincent Porter	2.12.2004
	Dr. Peter Goodwin	8.12.2004
Field trips	Professor Stewart Purvis	30.11.2004
	Voice of the Listener and Viewer	30.11.2004
	Field visit to BBC television centre	10.12.2004

See Appendices 8.1 and 8.1 relating to the interviewed persons.

Data collection plan

7.6.1.2.1.1 Document retrieval and analysis

Social networks

Content analysis

7.6.1.2.1.2 Interviews

The interviews were held in the London area, during a stay in the United Kingdom between November 27 and December 14, 2004. An hour and a half was asked for each interview. The actual time for the interview was between one and two hours. The interviews were taped on every occasion and the transcripts were made 24 hours after the interviews. Separate notes were made during the interviews. The ‘research diary’ notes include insights perceived during the session.

Expected preparation prior to site visits

Internet search on the person, current and prior affiliations

Careful checking of the question list

7.6.1.3 Outline of case study report

The report follows the structure of a normal dissertation.

The empirical part consists the following elements: historical setting with overview of technology, actors, and institutions, which is followed by the ‘story’ of competition. New elements are added if needed.

7.6.1.4 Case study questions

Open-ended questions concentrated on the launch of digital television, the evolving competition and its consequences. The introduction and the first questions are for the interviewee and the interviewer to orientate to the situation. The later questions aim to reveal the emphasis of competitive actions that major firms made. The interviewed people were asked to evaluate the diffusion not only on their own and on their organisations behalf, but to also consider the views customers and other participants had.

Introduction to the interviewees given by the interviewer

“The focus of this study is the competitive strategies of the television firms in the early years of digital television 1998-2002. My aim is to describe what actions major firms took and why, and what implications those actions had on the firms and society. I focus on competition between firms, especially between digital television channel packager i.e. satellite, terrestrial and cable platform operators. There is competition at several levels, between programs and between channels and between packagers. These interviews reveal different aspects of the problem, and with the other sources of information give the overall picture of the digital diffusion. I will use quotes, but I will not cite your name after the quote. Please, use examples and names of the companies because real world examples illustrate the dynamics in a clear way. “

7.6.1.4.1.1 Personal affiliation to the empirical domain

Describe your position in the time period between 1998-2002.

7.6.1.4.1.2 The industry outlook in 1998-1999

What firms, organisations, or regulatory bodies were the major actors leading the introduction of digital television? Give your personal insights on who had the initiative, and how they showed it? (Why)

How did the industry present the introduction of digital television? Was it MORE of the same traditional TELEVISION OR a NEW PRODUCT, or service offering altogether?

7.6.1.4.1.3 Reasons for complementor entry and early adoption

What was the importance of installed base of OLD ANALOGUE CUSTOMERS when new customers and new firms were thinking about digital television market?

If we take viewer's angle to the digitalisation, what role did TECHNOLOGICAL PERFORMANCE of channel packager's platform play among the first adopters at the LAUNCH?

What about the other television participants e.g. providers of channels, software, set-top boxes etc. what was the importance of technological performance of the platform for THEM? Examples.

Did the situation change AFTER the launch?

Still having the view of complementary product or service provider. Think back to a situation where a firm was considering introducing new product or service to one of the platforms operated by another company: What was the importance of offered VARIETY in the existing service of that platform? Was the variety i.e. number, or quality of other firms and channels already present a positive or negative sign.

What OTHER FACTORS contributed to the rise of number of channels and other services? Price, or terms in the contract...

Again, if we think about viewers... Compare the aspects of VARIETY to PRICE for customers? Did the preferences change?

Switching from one platform to another may cost money or time. How did these SWITCHING COSTS affect firms' behaviour in early digitalisation?

Packagers offered a growing number of services to a growing number of customers, let's call that totality as a platform network. What importance did this NETWORK SIZE have on further adoptions?

7.6.1.4.1.4 Core product provider competition

Did competition push the channel packagers to offer MORE VARIETY and distinctiveness or did the packagers IMITATE what the others were doing?

Were there any COMPETITIVE PHASES, BREAKING POINTS that changed rules of the game, looks or feels of television, industry leadership? What kind of competitive actions packager firms during those phases?

What's your view on how sponsoring the platforms affect packagers network and industry as a whole?

What about competitive bidding for television rights. Can you describe the importance of that in 98-02?

HOW DID YOU and your organisation VIEW the COMPETITION of the packagers? Was it good, or bad, did it require your action, or was there a need to wait how the events would unfold? Did the competition help, or harm the industry, and society?

7.6.1.4.1.5 Managing expectations

Participants active in digital television are much in public. Did the firms and other bodies MANAGE people's and other firm's EXPECTATIONS on diffusion and about the companies, and if so, how? What was the importance of this media presence?

Did the firms SUPPLY what they PROMISED? Was there a particular reason for the over/undersupply of quantity/quality?

I will try to give a good account of the dynamics in the diffusion. In order to help me in this quest is there something you would like to add on your behalf?

7.6.1.4.1.6 QUESTIONS IN RESERVE

How did imitative behaviour manifest itself?

Variety has both qualitative and quantitative aspects. In the packagers television offering which were more dominant and did the situation change?

I have noticed that the privately owned companies have strong hesitation to studies like this, compared to others. Do you have any suggestions why?

7.6.2 Principal news sources

Information on the publisher of Digital TV group news site filed 1.10.2004:

The Digital TV Group (DTG) is the industry association for Digital Television in the UK: an independent body facilitating the rapid roll-out of digital television and convergence across the communications industry. Its membership stretches from camera to consumer; from the BBC, BSkyB and OFCOM to Sony, Philips and Panasonic, Dixons and Comet through to the Consumers' Association, RNIB and RNID. Its agenda covers all aspects of future technology, public affairs and the setting, promotion and interpretation of standards and good practice.

The DTG was formed in 1995 to set technical standards for the implementation of digital terrestrial television (DTT) in the UK and now encompasses all digital TV platforms and convergence issues on a world-wide basis.

The DTG acts as a technical clearing house, publicising the work of members and providing a user-group to implementers around the world. It has established a wholly-owned subsidiary, DTG testing Ltd (web site), to

provide interoperability testing services to the industry. The DTG also fulfils marketing and regulatory roles on behalf of its members and the industry.

Membership of the DTG is open to all companies involved in digital TV broadcasting on all platforms with a commitment to published standards and open markets.

The DTG supports DVB standards and a non-discriminatory approach that will enable an open and competitive market in service provision, receivers and conditional access, which is consistent with the European Union Directive on Television Transmission Standards. The DTG D-Book (3rd Edition published June 1998, with subsequent revisions) sets out the detailed technical standards for digital terrestrial television in the UK.

DTG membership brings a range of benefits to any organisation in the digital television industry. The fundamental benefits for most are being able to participate in the development and implementation of important technical standards and to have a voice in activities that influence the regulatory regime. The DTG has an impressive record of forming a broad industry consensus and speaking with authority on many important issues to the great collective benefit of its many member companies.

In addition, DTG activities provide members with:

a regular forum to discuss latest technical developments

a regular forum to formulate important communications within the industry

a recognised mechanism for lobbying government and regulatory bodies

free subscription to Digital News - the magazine of the DTG

opportunities to promote specific member activities within the industry

general networking opportunities

preferential rates for receiver and application testing at DTG Testing Ltd

close contact with companies active in UK DVB-T implementation

access to the UK D-Book receiver specification, and other technical publications and confidential information via the members-only DTG ftp site.

opportunity to participate in the technical work of the DTG, through the activities of the working groups** (see section on Structure)

The DTG creates an environment that enables its members to:

investigate and specify important technical standards

influence the shape of the regulatory regime

communicate effectively with each other

Over 100 member organisations value the business benefits that arise from first-hand participation in such activities.

Information on Advanced.television.com news site and its publisher, filed on 1.10.2004:

www.advanced-television.com is published by Advanced Television Ltd. The company also publishes the leading industry journal Euromedia and is therefore able to offer advertisers a unique opportunity to run truly combined on and off-line campaigns. The principal of Advanced Television Ltd is Nick Snow who as head of 21st Century Publishing was responsible for the development of many leading media business titles including Cable and Satellite Europe and TBI-Television Business International.

Quick Facts:

October 2000: Launches at BCE 2000

January 2001: Launches Friday File, a weekly email digest of the news stories carried on the site.

May 2002: Launches Daily News, a daily email industry news service. Mailed at approximately 5pm London time it is in most recipients Inbox when they arrive at their desk in the morning. Quick Stats

Latest site stats: May 2003 1st Feb	30th Apr 03 1st Feb	30th Apr 02
Total Page mpressions	237,099	131,693
Unique Visitors (Average/ onth)	26,885	18,671

Average Daily Sessions	2,426	1,506
Total of Registered Users	7,383	
Total circulation of Daily	16,000*	
Total circulation of Friday File	33,000*	

*In addition to our Registered Users these names are hand picked from our over-all mailing lists which total some 65,000 email addresses. The criteria for all these names as a minimum qualification is that they have visited at least one of the following industry events within the last two years: Mediacast, BCE, Casbaa, IBC.

7.7 Binary categorisation of configurations

No.	Centrality	Example	Platform	Example	BSkyB	Example	Digital	Example	Imitation	Example
1	Present	"British Digital Broadcasting (BDB) is to spend a minimum of £553.7 million subsidising the take-up of digital terrestrial TV (DTG 9.1.1998)"	Present	See, centrality column	Present	"..free STB to customers spending more than £200 on a new TV in May, may match BSkyB" (DTG 6.4.1999)	Present	"Selected customers of BSkyB's current analogue service will be invited to take a decoder to allow reception of the first transmissions of digital television in the UK." (DTG 6.4.1998)	Present	see, BSkyB column
2	Present	"Ondigital accused Rupert Murdoch's BSkyB of failing to honour its contract to supply Sky Sports 2." (DTG 9.9.1999)	Present	See, centrality column	Present	see, centrality column	Absent	Content also in analogue	Present	"The deal means that Telewest will broaden the distribution of Sky One, already the UK's most-watched non-terrestrial channel..." (DTG 14.9.2002)
3	Present	[BSkyB] "has accused ITV of "withholding its channels (from Sky Digital) for private gain." (DTG 6.6.1998)	Present	See, centrality column	Absent		Absent		Present	see, centrality column

4	Present	" 'Football is the key driving force behind take-up of pay television... A pay television platform cannot be reliant upon a competitor for its key channels, so it was essential that we started to generate our own premium content,'" said Mr Prebble" (DTG 11.7.2001)	Present	see, centrality column	Present	see, centrality column	Absent		Present	" '...there must be some sports rights Sky don't have. Let's buy them!'. So, that's what they did, they bought second-tier sports rights, they paid crazy prizes for them (Interviewee 2)
5	Present	"...reminded the audience of the BBC's determination to remain at the heart of broadcasting with a wide variety of free-to-air channels. He looked forward to new children's programming on digital TV that wouldn't depend on imported cartoon" (DTG 15.11.1999)	Absent	see, centrality column	Absent	see, centrality column	Absent	"Sky aims to be the leading provider of entertainment, information and communication to the British home in the information age. The addition of radio services to Sky digital further enhances digital satellite television" (DTG 20.10.1999)	Absent	"BSkyB has donated three years of transponder capacity to The Community Channel" (DTG 5.11.1999)

6	Present	"From a standing start to almost half a million subscribers in less than a year is a remarkable feat. Unlike satellite and cable every one of our customers is new." (DTG 10.10.1999)	Present	"The switch to digital appears to be racing ahead of all predictions! BSkyB's announcement last week that they have reached 4.1million: add on more than 900,000 Ondigital digital subscribers,[...] 350,000 and 150,000 from ntl and Telewest "(DTG 10.11.2001)	Present	see, platform column	Absent		Present	see, centrality column
7	Absent		Present	"Telewest talks to buy General Cable; also seeking...two London and Birminham franchises" (DTG 14.4.1998)	Absent		Absent	"The headline news from Telewest today is that the company has now converted almost half its TV subscriber base to digital - 532,000 (DTG 6.6.2001).	Present	see, platform column,; "[NTL to] Acquire ComTel and Diamond...[in a]...£1.4million deal" (DTG 17.6.1998); "NTL Buys Eastern Group...said to be worth £90 million" (DTG 29.12.1998)
8	Absent	"Grundig, Hitachi, Matsushita, Philips, Sharp, Sony, Thomson and Toshiba had created draft specifications that would enable digital AV appliances to be interconnected and interoperated in an integrated home network system." (DTG 20.4.1998)	Absent	see, centrality column	Absent	see, centrality column	Present	see, centrality column	Absent	"[ITN] said that ntl are the perfect partner to exploit the opportunities offered by new technology and digital broadcasting, including interactivity and Enhanced Television, which will distinguish the channel from its competitors. "(DTG 18.2.2000)

9	Present	"Our successful relationship with OpenTV allows the BBC to deliver a groundbreaking service like Wimbledon Interactive that puts BBC viewers in the thick of the action like never before and offers them unprecedented choice..."(DTG 16.5.2001)	Absent	"Viewer feedback tells us that there is an untapped demand for late-night adult entertainment," said Two Way TV commercial director Jean de Fougérolles. 'We are constantly looking for new and innovative formats to drive revenues through our games channel'" (DTG 19.6.2002)	Absent	see, centrality column; "Are the British catching on to interactivity at last? If so, it's Big Brother what done it!" (DTG 19.6.2001)	Present	see, centrality column	Absent	see, centrality column; "Big Brother has confounded critics of enhanced TV, and proved how a creative approach can be a real hit with TV viewers."(DTG 19.6.2001)
10	Absent	"Telewest Communications, has bought Rapid Travel Solutions, a software company that links travel companies to an online booking system. This will enable people to view video clips of hotels and holiday resorts."(DTG 5.6.2001)	Absent	"Bargainholidays.com is to target Hull-based digital TV viewers through its new service on Kingston interactive" (DTG 8.7.2002).	Present	"[Open is] offering the first largescale opportunity for e-commerce from the TV (DTG 12.10.1999)	Present	see, centrality and BSkyB columns	Absent	

11	Absent	"Instead of just watching adverts, viewers across the country can now find out more about advertisers' products and even buy them straight away." (DTG 27.3.2000)	Absent	see, centrality column	Present	"Britain's first interactive television commercial will be screened this week on Sky Digital."(DTG 27.3.2000)	Present	see, BSkyB column	Absent	
12	Absent		Present	"Consumers in NTL's broadband cable franchises are now free to choose Freeserve Broadband as part of bundles with cable telephony and TV packages."(14.5.2002)	Absent	"[NTL offers] cut-price phone services, Internet and e-mail via phone." (DTG 24.4.1998)	Present	"It's very much bundled service, not exclusively digital TV. Also, they are now using some of that bandwidth, some of the capacity to develop broadband services, which again adds features to the bundle of services they [cable companies] offer. (Interviewee 2]	Present	"[BSkyB] said their aim was to compete effectively with the cable industry, which will launch digital cable later this year " (DTG 6.4.1999) I don't think that people or that many people would by it for the digital television, but if you want digital television AND telephony then it's probably a good option. Sky has responded to it by offering its own telephony (Interviewee 2)

13	Present	"The BBC decided that not only [it] could not be left behind...[from the launch of digital satellite, but had to be active] (Interviewee 1) "BBC and Sky have agreed terms for the carriage of BBC free-to-air services on Sky Digital" (DTG 6.6.1998)	Absent		Absent		Present	"Satellite in digital is very different than satellite in analogue. It is much wider product, broader appeal, it is value addition to analogue. And you pay the same and get many more channels. (Interviewee 3)	Absent	see, digital column
14	Absent		Present	"BDB would charge a subscription rate of under £10 per month, aiming its services at 'the families of middle England' who had not been attracted to take BSkyB services" (DTG 8.5.1998)	Present	"Because, Sky very much is a market leader and it has I think pretty much dictated how other people were able to sell their packages." (Interviewee 2)	Present	"So, you get multiplication of channels, but not necessarily multiplication of original content. The viewer things he is getting more..." (Interviewee 3)	Present	"[ITV Digital] it was forced to sell its packages in very similar ways (Interviewee 2)

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8.1 Semi-structured interviews

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- Allan Williams is Senior Policy Advisor of Consumers Association ‘Which?’. Interview held 12/3/2004, at Consumers Association ‘Which?’.
- Julian McGougan is BBC Public Policy Senior Advisor, formerly worked as a policy adviser for commercial television regulator ITC, and earlier worked for telecommunications regulator Oftel. Interview held on 12/6/2004 at BBC
- Michael Starks is the Project Manager at Department of Trade and Industry for the UK’s Digital TV Action Plan – the joint government-industry project designed to inform Ministers’ decisions on the UK’s full switchover to digital television. He formerly directed the BBC’s free-to-view Digital TV project (Freeview), Earlier he was BBC’s director of Customer Service, the Controller of the BBC Digital Broadcasting, and the founding Chairman of the industry-wide Digital TV Group. Interview held on 12/8/2004 at DTI.

8.2 Informal interviews

- Professor emeritus Vincent Porter, University of Westminster, School of Media, Arts and Design, acted formerly as a professor of mass communications. Discussion on the 2nd of December, 2004 in London.
- Dr. Peter Goodwin, University of Westminster Communication and Media Research Institute, formerly worked as a journalist writing about the television industry. Discussion on the 8th December, 2004, at University of Westminster.
- Professor of Television Journalism Stuart Purvis at London City University and Financial Times columnist, former Editor of Independent Television News

(ITN) Channel Four News, ITN's Chief Executive. Discussion on the 30th November, 2004 at Voice of the Listener and Viewer Seminar.

- Field visit to BBC television centre on 10th December, 2004.

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