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INSTITUTIONS, TECHNOLOGY AND MARKETS IN INDUSTRY EVOLUTION

Causal and Evolutionary Mechanisms in a Regulated Industry

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ABSTRACT OF DOCTORAL DISSERTATION

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Abstract

This study focuses on the interplay between institutions, technology and markets in industry evolution. Existing research on industry evolution may be categorized into two distinct explanatory logics. At one end there are market based explanations, which assume competition and imitation, and emphasize the role of technological change as a key determinant of long term change. At the other end is the institutional approach, where the focus is on the impact of history and social structures. Most industries exhibit both explanations. The key goal of this study is to build a bridge between these distinct streams of research and to identify the characteristics of the focal mechanisms that explain organizational survival and death and subsequently the patterns of industry lifecycles in regulated industries.

This study conveys the principles of causality as addition to the prevailing theories of industry evolution and evolutionary economics. In order to provide causal explanations the analysis is extended to multiple levels. The empirical analysis of the study focuses on a heavily regulated, and later deregulated, industry – the electric power industry in Finland between 1889 and 2005.

This study provides four key contributions. First, it offers causal explanations as a complementary element to provide an evolutionary explanation. Second, in addition to the existing constructs, the research provides an evolutionary explanation through mechanisms, which are either evolutionary or causal, and either emergent or with identified agency. Consequently, the long-run change is seen as a result of the interplay of both the causal and evolutionary mechanisms. Third, the study produces a multi-level research framework, which is needed when giving a causal explanation in evolutionary research. Fourth, compared to the extant studies of industry life cycles, the causal explanations provide explication of the differences in the industry life cycle caused by public policy actions and external shocks.

The research also has implications for practice. It shows that public policies have primary causal and secondary emergent impacts on industry structure and firm survival. It also provides evidence that evolutionary path dependence and asset constraints cause far-reaching impacts on public policies at both industry and firm level. Moreover, its shows how external shocks intervene the ‘normal’ evolution of the industry and the antecedent intended causal impacts of public policies. And finally, it provides evidence that in a deregulated industry a firm’s business model and its vertical integration act as a key selection criteria both prior to and after deregulation.

Keywords: Industry evolution, mechanisms, causality, institutions, regulation, deregulation

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Työn ohjaaja	Professori Juha-Antti Lamberg (Teknillinen korkeakoulu)

Tiivistelmä

Väitöskirjassa tutkitaan instituutioiden, teknologian ja markkinoiden vuorovaikutusta toimialaevoluutiossa. Aiemman tutkimuksen selityslogiikka voidaan ryhmitellä kahdella tavalla. Toinen ryhmä koostuu markkinapainotteisista selityksistä, joiden olettamuksena on kilpailun ja jäljittelyn vapaus markkinoilla. Tutkimukset korostavat teknologian roolia pitkän aikavälin muutoksen selittäjänä. Toisen ryhmän muodostaa institutionaalinen lähestymistapa, joka tutkii toimialan historiaa ja korostaa sosiaalisten rakenteiden merkitystä muutoksessa. Tämän tutkimuksen tavoitteena on rakentaa silta näiden kahden tutkimussuunnan välille ja identifioida niiden mekanismien ominaisuudet, jotka selittävät organisaatioiden eloonjääntiä ja kuolemaa ja edelleen muutoksia säädellyissä toimialoissa niiden elinkaaren aikana.

Tutkimuksessa hyödynnetään kausaliteettitutkimuksen periaatteita ja sovelletaan niitä toimialaevoluution selittämisessä. Jotta kausaalisia selityksiä voidaan antaa, tutkimuksen analyysi toteutetaan usealla eri tasoilla; yhteiskunnan, julkisen päätöksenteon, toimialan ja yritysten näkökulmasta. Tutkimuksen empiirinen osuus keskittyy Suomen energiateollisuuteen, joka on ollut voimakkaasti säädelty koko elinkaarensa aikana.

Tutkimus edistää toimialaevoluutiotutkimusta neljällä eri tavalla. Ensinnäkin se tarjoaa kausaaliset syy-yhteydet täydentämään perinteisiä evolutionäärisiä selitysmalleja. Toiseksi se osoittaa, kuinka pitkän aikavälin muutosta voidaan selittää sekä kausaalisilla että evolutionäärisillä mekanismeilla, jotka ovat joko määrätyn tekijän aikaansaamia tai itsestään syntyviä. Kolmanneksi, tutkimuksen tuloksena on syntynyt moniulotteinen tutkimuskehikko, jota tarvitaan, jotta kausaalisia selityksiä voidaan antaa evolutionäärisessä tutkimuksessa. Neljänneksi, tutkimus osoittaa, että poliittisten päätösten ja toimialan ulkopuolisten suurten muutosten käynnistävien kausaalisten mekanismien avulla voidaan selittää toimialojen elinkaarien eroja verrattuna olemassa olevaan elinkaaritutkimukseen.

Tutkimuksella on myös käytännön vaikutuksia. Tutkimus osoittaa, että poliittisilla päätöksillä on sekä suoria primäärisiä että sekundäärisiä vaikutuksia toimialojen rakenteeseen sekä yritysten menestymiseen ja selviytymiseen. Julkisella päätöksenteolla on kauaskantoisia vaikutuksia sekä toimiala- että yritystasolla. Lisäksi toimialan ulkopuolelta tulevat suuret muutokset muuttavat toimialan 'normaalia' kehityskulkua sekä aiemmin tehtyjen julkisten säädösten ja poliittisten päätösten aiottuja vaikutuksia. Tutkimus osoittaa myös, että säädellyllä toimialalla yrityksen liiketoimintarakenne ja vertikaalisen integraation aste ovat vaikuttavat merkittävästi yrityksen menestymismahdollisuuksiin sekä markkinoiden säätelyn että deregulaation aikakaudella.

Avainsanat: Toimialaevoluutio, mekanismit, kausaalisuus, instituutiot, regulaatio, deregulaatio

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The history of this dissertation is not as long as the history of the electric power industry in Finland. However, the dissertation itself is certainly a result of an evolutionary process with direct causal impact of several individuals, to whom I am deeply indebted.

The foundation of this study was laid in autumn 2005, when I started my postgraduate studies in Helsinki University of Technology (HUT). One of the first courses I attended was 'Industry Evolution' led by Professor Juha-Antti Lamberg. I conducted a study of the life cycle of the electric power industry in Finland as a course assignment. The data gathering and the first ideas from those days laid the basis for this dissertation. The course assignment later evolved into an Academy of Management 2006 conference paper, article manuscripts, and finally towards this doctoral disseration. I am grateful to the guidance and encouragement of Juha-Antti and Professor Johann Peter Murmann, a co-lecturer of the course, who ignited my interest on co-evolution and institutions.

I was extremely fortunate to get Juha-Antti as a supervisor for my work. In addition to his deep knowledge of strategy and organizational research, Juha-Antti has an exceptional capability for coaching; to excite and motivate his students. He does not hesitate to commend an achievement, nor does he fear to give direct though constructive criticism. After reviewing an early version of my dissertation manuscript I received a mail from Juha-Antti stating clearly that the text was far from an acceptable academic level. "The central problem is the superficiality of the text …now you need to make a mega jump and go back to the basics …", he concluded and suggested a one-to-one meeting. I really enjoyed our meetings. I always left them full of energy, with new ideas and a clear goal to be achieved.

During my studies I was amazed of the deeply professional, internationally networked, humanly warm and encouraging learning atmosphere of the Institute of Strategy in HUT. I want to give my warmest gratitude to the lecturers at HUT; Professor Tomi Laamanen, Docent Mikko Ketokivi, Professor Saku Mantere, and Professor Markku Maula, with whom I was privileged to work and who diffused the positive atmosphere together with Juha-Antti. The foundation of the theoretical body of knowledge and the principles of research methodologies of this dissertation were created in the modern and interactive seminars conducted by these gentlemen.

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I am sincerely grateful also to my parents, Osmo and Helvi Moilanen, who have encouraged and supported me to set challenging goals in life and to do my utmost to achieve them. Education has not only been the career of my farther, but also his passion. His everlasting interest to gain and share knowledge through discourses with both scholars and practitioners in a wide variety of disciplines has been an example for me throughout my life.

I owe an apology to my children, Olli, Mikael, Ilari and Eero. I was not always mentally present when I was needed. However, I want to thank them that during these years we were able to share together the most important ingredients of life: love, happiness, and forgiveness – and the enjoyment that comes from friends, passion and persistence.

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Helsinki, September 2009

Markku Moilanen

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1. INTRODUCTION

1.1. Focus of the research and research motivation

According to the existing scholarly literature long-term change in industries and organizations – changes in industry structure, shakeouts and firm survival – are a result of an interplay of firms and underlying market mechanisms (Schumpeter, 1934), technological change (Nelson and Winter, 1982; Klepper, 1997), and surrounding institutions and public policies (Nelson, 1995a, 1995b; Nelson and Sampat, 2001; Murmann, 2003; North, 1990, 2005). Accordingly, we may identify distinct streams of research, which diverge from each other both methodologically and by the assumptions of the major influential forces and determinants of the change. At one end market based explanations assume free competition and imitation, and emphasize the role of technological change as a key determinant of long-term change (Klepper, 1996, 1997, 2002, 2003; Klepper and Simons, 2000a, 2000b, 2005; Mowery and Nelson, 1999). At the other end, we may identify a historical, qualitative approach with a focus on the impact of institutions (North, 1990, 2005; Murmann, 2003; Lamberg and Laurila, 2005; Lamberg and Tikkanen, 2006; Ingram and Inman, 1996; Holm, 1995).

The market based explanations of industry life cycles (Klepper, 1997) emphasize the role of technological change in shaping the evolution of industry structures. Following the basic tenets of product life cycle theory, industries are considered to evolve through distinctive phases. This body of research provides explanations of why the number of firms in an industry falls sharply after a long period of steady growth and what types of firm survive the shakeouts. The conclusions are, in short: the older and larger a firm is and the more it invests in research and development (R&D) the better potential it has to survive over the life cycle of the industry. The older and larger firms are seen to be closer to the technological frontier, which enables them to survive longer. The research on industry life cycles also provides useful perspectives on one important characteristic of industry evolution, namely path dependence (Nelson and Winter 1982, 2002; Puffert, 2002; Cattani, 2005, 2006) – this is the reliance of one of several preceding actions and decisions in the past. There is a large volume of empirical evidence that the theoretical model of industry life cycles introduced by Klepper (1996, 1997) holds over a wide set of industries (see Klepper 2002, 2003; Klepper and Simons, 2000a, 2000b, 2005; Mowery and Nelson, 1999). However, as Klepper and Simons (2000) have pointed out, the model does not take into account the impact of institutions such as government policies and market institutions.

However, conversely, there are a group of studies that emphasize the importance of institutions on long-term change in industries (North, 1990, 2005; Nelson, 1986, 1995a, 1995b, 2005). In addition to the benefits of age and size, and exploitation of technology, these studies examine the impact of institutions in order to provide a central explanation of the grounds of a firm’s competitive advantage and their long-term survival. These studies provide explanations for cases in which dynamic change comes from outside of an industry, such as an external development of science (Nelson, 1986; Nelson and Winter, 2002), from environmental uncertainty (Lewin et al., 1999; Anderson and Tushman, 2001), or from institutions such as public policy actions, legislation and regulation (Holm, 1995; Ingram and Inman, 1996; Murmann, 2003; Lamberg and Laurila, 2005; Breznitz, 2005). Methodologically this approach frequently employs historical narratives (Abrams, 1982; Sayer, 1992; Griffin, 1993; Mahoney, 1999) supported by descriptive numerical analysis (see Murmann, 2003; Geels, 2002, 2005, 2006, 2007) or quantitative analysis (see Lamberg et al., 2008).

Both of the perspectives outlined above have their merits. However, most real industries manifest the importance of both explanations. It could be argued that market based explanations dominate in open market industries, while public policy actions dominate in more or less regulated industries, such as telecommunications, electric power industries, airlines, train and postal services, and in banking and insurance[1], many of which are, or have been, considered as natural monopolies (Winston, 1998; Joskow, 2007). Legislation and regulation define, without doubt many of the 'rules of the game' (North, 1995; Coleman, 1995) or the environmental conditions (Nelson and Winter, 1982; Aldrich, 1999; Nelson, 1995b) in the regulated industries. On the other hand, the firms in regulated industries still strive to get the best possible results according to the rules of the game. Thus there are also *market mechanisms* active in these industries. In addition, in long-term change evolutionary processes (Campbell, 1969) *evolutionary mechanisms* (Nelson, 1995b) are always active.

The impact of institutions and public policy actions on industries cannot be explained solely with evolutionary and market mechanisms. Nor can it be explained simply with the "rules of the game" type of reasoning. The often sudden and purposeful impact of public policies on industries asks for more fine-grained explanations. Causal research offers a solution for this dilemma. In the industry evolution literature mechanisms as constructs are considered to be the 'causal links' between events of phenomena (Nelson, 1995b; Murmann, 2003). However, traditionally causality (Pearl, 2000) has not been recognized or been taken into account as part of the evolutionary explanation. Recently, on the other hand,

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[1] Regulated industries are here considered industries, in which – at least during some episodes –government legislation, regulation and public policies has determined the principles of competition, pricing and rights to carry on business in the industry.

Lamberg et al. (2008) introduced causal arguments and causal pathways as a fundamental part of an explanation for long-term organizational survival. The use of mechanisms has, however, moved towards rigorous definitions in other areas of the social sciences to explain organizational processes or to find out why and how something occurs (Coleman, 1990; Glennan, 2002; Hedström and Swedberg, 1998; Machamer et al., 2000; Pajunen, 2004, 2008; Sawyer 2004; Tilly 2001). According to this body of research, mechanisms explain causal connections between events across multiple levels of analysis. In some cases mechanisms form chains which ultimately cause the long-term change to occur. Mechanisms are also frequently interlinked with agents who induce the mechanisms. Indeed, the need to provide further explanations of *how* and *why* institutions impact evolutionary change and industry life cycles, and the potential for that explanation with the use of the concept of a mechanism jointly shaped the research motivation of this study; *to identify the characteristics of the mechanisms that explain organizational survival or death and subsequently the patterns of industry lifecycles in regulated industries.*

In this study, I will, as Whetten (1989) and Aldrich (1999) suggested, draw ideas and perspectives from several approaches and fields. This is carried out by conveying the principles of causality (Pearl, 2000; Sawyer, 2001; Hodgson, 2007; Morgan and Winship, 2007) together with the prevailing theories of industry evolution. I also make use of ideas of mechanisms from sociology (Coleman, 1990; Hedström and Swedberg, 1998; Hedström, 2005) and offer a complementary evolutionary explanation by adding causal explanations to the evolutionary ones. Conceptually, the explanation therefore includes the combined impact of both evolutionary and causal mechanisms. In order to provide causal explanations I perform the analysis at multiple levels (Pettrigrew, 1992; Geels, 2002, 2005). I provide explanations with mechanisms that are active across different levels of analysis and thus explain causal micro-macro links (Alexander et al. 1987; Coleman, 1990) within the long-term change process. Accordingly, I selected the electric power industry as the focus of the empirical analysis of the study since, as a regulated industry, it is distinguished from open market industries, and during its life cycle has been heavily affected by surrounding institutions in the form of legislation, regulation and public policy actions. The goal of the empirical analysis of the

electric power industry in Finland between 1889 and 2005 is to explain the process and the key mechanisms and determinants that have caused the industry structure to evolve over the years and to explain why certain kinds of firm have survived while others have disappeared from the industry.
This study offers the potential to enrich theories of organizational change by combining several streams of research. However, it should be noted that many of the discourses that have been linked in the study are often disparate and disconnected with different interests and in some cases conflicting theoretical assumptions. Hence, it is relevant to draw attention to the relevant scholarly discussions that this study is associated with and contributes to and consequently the target audiences for the dissertation.

First, the study follows the tradition of an eclectic approach to the evolution of industry and organizational change (such as Ingram and Inman, 1996; Ingram and Simons, 2000; Rao, Monin and Durand, 2003; Durand, 2006; Durand and Calori, 2006) and thereby is able to offer a more holistic picture of the actors and processes operating at multiple levels. It has been showed that the distinct approaches of industry evolution can be connected in order to offer a wide view of organizational change (Lewin and Volberda, 1999; Volberda and Lewin, 2003b; Durand, 2001, 2006) and that pan-disciplinary research that combines several theories can extend our understanding of the process of change (Ingram and Clay, 2000).

Second, by extending our understanding of industry life cycles (Klepper, 1996, 1997, 2002, 2003; Klepper and Simons, 2000a, 2000b, 2005; Mowery and Nelson, 1999) this study contributes to the discourse concerning the impact of surrounding institutions and public policies and technology on industry evolution (Nelson, 1995a, 1995b; Nelson and Sampat, 2001; Murmann, 2003; North, 1990, 2005) and co-evolution (Nelson, 1986, Lewin and Volberda, 1999; Lewin et al., 1999; Volberda and Levin, 2003a; 2003b) as a particular phenomenon.

Third, the findings concerning the generative mechanisms active throughout the industry life cycle builds on the research of causality in social sciences presented by Coleman (1990) and Hedström and Swedberg (1998) and continues the recent discourse on mechanisms and their characteristics (Machamer et al. 2000, Glennan, 2002, 2005, 2007; Mayntz, 2004; Bunge, 2004; Pajunen, 2004, 2008).

Finally, the empirical part of the dissertation offers interesting new insight on regulation and deregulation; especially in the electric power industry (Amundsen and Bergman, 2005; Bergman, 2002; Bergman et al., 1999, Jamasb, 2002; Joskow, 1998, 2003a, 2003b, 2007; Newbery, 2002; Sine and David, 2003; Kara et al. 2008; Verbruggen, 2008).

1.2. Key contributions and results

This study contributes to the industry evolution and evolutionary economics literatures in three distinct ways. First, the conceptual integration of the different streams of literature offers a novel way to explain long-term industry and firm evolution. Conveying the principles of causality and the characteristics of organizational mechanisms offers a new and complementary component to the evolutionary explanation. The study also utilizes a methodologically interesting *research framework*, which offers a conceptualization of the high-level interdependencies between the different levels of analysis. Complementing the existing literature on industry dynamics the analysis drills downs to underlying fine-grained mechanisms to explain how change occurs. Thus, this study provides an insight into the multi-level nature of industry evolution and to the fine-grained causal and evolutionary connections between the macro and micro levels of change in particular. In addition, the analysis shows that visual mapping (Miles and Huberman, 1994, Langley and Truax 1994; Mintzberg et al., 1976) with *causal diagrams* (Pearl, 2000; Pajunen, 2004) that interlink the distinct levels of analysis is a plausible and logically consistent method in order to provide an explanation.

Second, the study elucidates the characteristics of the focal mechanisms that explain organizational survival and death in a novel way. The fine-grained explanation of evolutionary change is not only composed of the impact of evolutionary mechanisms, but also of the effect of causal mechanisms. Whereas the evolutionary mechanisms are by nature emergent, the causal mechanisms may either be emergent or agency identifiable. When the two types of mechanism are in action simultaneously, the outcome is the combined result of both. This provides a fine-grained explanation for a phenomenon, in which an intervention of a public policy action induces a causal mechanism, which interferes with the underlying 'natural evolution' of an industry, and thus modifies the outcome of the active evolutionary mechanisms. The explanation of an industry life cycle and individual firm survival includes three kinds of processes and mechanisms: (1) an underlying evolutionary process with mechanisms to induce variation, selection and retention, (2) market mechanisms according to the both the formal in informal "rules of the game" in the industry, and (3) the causal mechanisms activated by several institutions and environmental shocks.

Third, the study shows that the pattern of a regulated industry life cycle is, to some extent, different from the life cycles of traditional open market industries (cf. Klepper, 1997). The Finnish electric power industry underwent two shakeouts during the end of the 20^{th} century. The latter was caused by legislation and regulation and the preceding and subsequent events in the three levels of analysis: society and institutions, industry and firms. Furthermore, the business model (Amit and Zott, 2001; Venkatraman and Henderson, 1998; Tikkanen et al., 2005) of a firm was a key evolutionary selection criterion during the overall life cycle of the industry – and during the shakeouts in particular. The business model of a firm is a manifestation of its blueprint or DNA – a long-term storage of information of the firm and its evolution. The corollaries of historical path dependence and coevolution with surrounding society, particularly other industries and firm owners, are stored in the business model of a firm.

The study provides evidence that the structure of the electric power industry in Finland in 2005, the dominant firms and the distinct business models, cannot be understood without coming to terms with the interplay of institutions, external shocks, technology and markets, and the complex impact of underlying causal and evolutionary mechanisms throughout the history of the industry. In addition to the theoretical contributions, this study has several practical implications for both public policy making and for the key stakeholders of electric power industry firms. First, I explain how the public policy makers have an agency role and use a ‘visible hand’ – sometimes purposively, sometimes unintentionally – with causal impact on both industry structure and on individual firm survival. This is due to the fact that public policies have primary causal and secondary emergent impacts on industries and firms. The emergent and often unintentional impact is a result of the interplay of the direct causal mechanisms and the underlying evolutionary mechanisms. Second, I explain how and why evolutionary path dependence and asset constraints cause far-reaching impacts on public policies at both industry and firm level. Third, I show that external shocks intervene the ‘normal’ evolution of the industry and are the antecedents of intended causal impacts of public policies. Good examples of such external shocks are the Oil Crisis in the 1970s and the recent challenges associated with climate change. Climate change has attested again that great environmental challenges will increase the uncertainties of upcoming changes of regulation and public policy actions – such as taxation of windfall profits or government subsidies on new energy technologies. The investment lifetime of power generation plants is often tens of years and a substantial amount of financial capital is tied up in these investments. It is therefore crucial to understand the long-term impacts of the distinct actions on different levels, as deregulation might not be the end of the story of regulation – there might be new kinds of regulations on the horizon for the industry and for society as a whole.

1.3. Structure of the dissertation

This dissertation is divided into eight chapters. After this introduction, mechanisms and causality as part of the evolutionary explanation are presented and reviewed in Chapter 2. The chapter starts with a definition of the hierarchy of the temporal scopes of analysis. Thereafter, the different approaches to mechanisms and their characteristics that are found in the industry evolution scholarly literature are reviewed. Next, causal explanations and the key characteristics of mechanisms in the social sciences scholarly literature are reviewed. Following this, two important concepts and phenomena in industry evolution; co-evolution and path dependence are explained by making use of mechanisms. In the concluding part of the chapter the findings of the review are summarized in the form of the research motivation and research problem. In order to provide an answer to the research problem defined at the end of the second chapter, I first build an extensive research framework for the remainder of the study. The framework is presented at the start of Chapter 3. The components of the research framework are thereafter thoroughly reviewed based on the existing scholarly literature. Three research questions, which were built on the findings of the review, are presented at the end of the chapter. In Chapter 4, a detailed review of the existing research of the electric power industry is carried out on the basis of the research questions. Based on the findings of this review three research propositions are offered which are scrutinized in the empirical analysis.

The methodology of the study; the research site, research design and data sources are presented in Chapter 5. There follows the historical analysis of the electric power industry in Finland between 1889 and 2005 which is presented in Chapter 6. First, the four periods of the history of industry are portrayed. Following this the structure of the research framework, the evolution of public policies in the industry is analyzed. Subsequently, the evolution of electricity consumption and power generation technology and the evolution of distinct firm business models are studied and the key selection criteria are summarized. Finally, the two shakeout episodes of the industry are scrutinized, causal diagrams of the key events leading to the shakeouts are depicted and the key mechanisms during the evolution of the industry are outlined. The key theoretical findings are discussed in Chapter 7: the nature of mechanisms in an evolutionary explanation and characteristics of a regulated industry evolution. Finally, in Chapter 8 the key contributions to scholarly discourse are summarized, practical implications are offered and the limitations of the study as well as suggestions for further studies are discussed.

2. MECHANISMS AND CAUSALITY IN EVOLUTIONARY EXPLANATION

The organization and management literature has for a long time been interested in long-term change. The principal interest for scholars is *how* the change takes place and *what* the reasons behind the change are. Furthermore, their profound aspiration is to understand and explain *why* the change occurs. For scholars of industry evolution the centre of attention is on the interplay of an organization and its environment. According to the prevailing theories, change originates from distinct *mechanisms*, which cause a change to occur (Nelson and Winter, 1982; Aldrich, 1999; Nelson, 1995b). Analytically the focus is on "a variable or a set of them that is changing over time and the theoretical quest is for an understanding of the dynamic process behind the observed change; a special case would be a quest for understanding of the current state of a variable or a system in terms how it got there" (Nelson, 1995b:54). Consequently, the change that is seen in a variable of a given level of analysis between two selected points of time is a result of a chain of multiple events and the active mechanisms between the events. As Van de Ven and Poole (2005:1385) have put it, a process theory of change "needs to go beyond a surface description, to penetrate the logic behind observed temporal progressions. This explanation should identify the *generative mechanisms* that cause observed events to happen in the real world, and the particular circumstances or contingencies when these causal mechanisms operate."

In this chapter, mechanisms will firstly be placed in the multidimensional landscape of levels of analysis and temporal scopes of analysis in the organization and management literature. Thereafter, the approaches to mechanisms in industry evolution and evolutionary economics literature are reviewed. Since causality is one of the key characteristics of mechanisms, causal explanations are reviewed and discussed first as part of the industry evolution literature and then in the social sciences scholarly literature in general. Next, the key characteristics of mechanisms are reviewed and summarized. Then, two important evolutionary concepts and phenomena – coevolution and path dependence – are elucidated by making use of mechanisms. Finally, based on the review, the research motivation of the study is summarized at the end of the chapter.

2.1. Temporal scopes of analysis

The analysis of industry evolution is a multi-dimensional exercise, in which one has to select not only the level of analysis, such as society, the institutions, an industry, a firm, or the individuals[2] (Aldrich, 1999), but also the span and scope of the temporal dimension of analysis. The selection of both the level of analysis and the temporal scope of analysis depends on the desired graininess of the analysis. It also often represents the selected epistemological standpoint of the research; methodological collectivism or methodological individualism, as elaborated in the next chapter. The four scopes of analysis in the temporal dimension of social sciences, and industry evolution research in particular, are described in Table 1. First, starting from the bottom of the table, *mechanisms* form the lowest temporal scope of analysis,

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[2] The distinct levels of analysis in this study are presented in detail in Chapter 3 together with the research framework.

combining a set of events and the change relations between the events in identical or closely similar ways over a variety of situations (Tilly, 2001). Thus, mechanisms are useful constructs to provide a fine-grained analysis of a phenomenon. Second, *processes* are concatenations of mechanisms, frequently occurring combinations of mechanisms. In the industry evolution tradition, which builds on general evolutionary theory, processes – such as variation, selection and retention (Campbell, 1969) – are often at the center of the analysis.

Table 1: Distinct temporal scopes of analysis in the temporal dimension of social science research

Temporal Scope of Analysis	Presented by	Description
Lifetime	Nelson and Winter (1982) Hannan and Carroll (1992) Klepper (1997)	Whole life of a population or an organization from the entry of the first member to the exit of the last one.
Episode	Tushman and Romanelli (1985) Tilly (2001)	Temporally selected, bounded stream of social life.
Process	Campbell (1969) Van de Ven and Poole (2005)	High-level causal process explaining long-term change (e.g. variation, selection, retention).
Mechanism	Nelson (1995b) Coleman (1990) Hedström and Swedberg (1998) Machamer et al. (2000) Bundge (2004) Mayntz (2004)	Construct explaining the relationship between two entities or events.

Third, *episodes* are bounded streams of social life. Episodes are, in general, the areas of interest during the lifetime of an organization. Certain episodes have a more important effect on industry structure and survival than others; thus they have a cohort effect (Aldrich, 1999) on firms and industries[3]. Examples of such episodes are shakeouts, during which the number of firms in the industry rapidly decreases after a long period of growth (Klepper, 1997), environmental jolts (Meyer, 1982) and episodes with increased environmental turbulence (Lewin et al., 1999). The research challenge in the analysis of these kinds of episodes typically includes the question of why the shakeout occurs and how the environmental turbulence impacts the industry structure and organizational survival. Fourth, *lifetime* represents the highest temporal scope of analysis and includes the entire life cycle of a population from the entry of the first member to the exit of the last. In this study, I have used several temporal scopes of analysis depending on the purpose of the analysis. I start from the entire lifetime of an industry to identify the key episodes during the life cycle of an industry. Then I drill down in the episodes and elucidate and explain the phenomena observed in the higher scope of analysis by making use of mechanisms.

2.2. Mechanism as a fine-grained construct of explanation

2.2.1. Approaches to mechanisms in the industry evolution literature

The concept of a mechanism is used in industry evolution theories to explain how high level change processes operate at three different levels of analysis; on the level of the industry, within the firms, and between the levels. A summary of the approaches to mechanisms in the industry evolution literature is presented in Table 2.

First, the most general use of the concept is at the level of the industry. At this level mechanisms are used to explain high-level evolutionary Variation-Selection-Retention (VSR) (Campbell, 1969) change processes.

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[3] Aldrich (1999) defined three components of an evolutionary-historical framework for understanding organizational change. The three components are an age effect, a period effect and a cohort effect. The age effect is inherently associated with the existence of the firm or the industry. The period effect and the cohort effects are related to certain time frame during the life cycle of the industry. In the period effect the impact is same for all firms; in the cohort effect the events and forces have different effect on different organizations.

Table 2: Mechanisms in industry evolution literature

Related to	Mechanism (m.)	Presented in article
General	Selection mechanism	Hannan and Freeman, 1977; Murmann, 2003; Nelson, 1995b
	Variation mechanism	Campbell, 1969; Nelson, 1995b
	Retention mechanism	Nelson, 1995b
	Mutation mechanism	Levinthal, 2006
	Change inducing and winnowing m.	Nelson, 1995b
	Rolling snowball mechanism	Nelson, 1995b, Murmann and Frenken, 2006
	Self-reinforcing mechanism	Murmann, 2003; Nelson and Winter, 2002
Industry level	Internalization mechanism	Puffert, 2001, 2002
	Structural change mechanism	Hannan and Freeman, 1977
Market and competition	Market mechanism	Nelson 1995b; Nelson and Sampat, 2001, Murmann et al., 2003, Verbong and Geels, 2007
	Competition mechanism	Hannan and Freeman, 1977
	Co-operation mechanism	Barnett and Hansen, 1996
	Sponsorship by powerful actors and organizations	Hannan and Carroll, 1992
	Isolating mechanism	Mahoney and Pandian, 1992
	Niche-cumulation, technological add-on and hybridization	Geels, 2002
	Market stabilizing mechanism	Geels, 2005, 2006
	Imitation mechanism	Nelson and Winter 1982; Nelson, 1995b
Dominant design and path dependence	Successful variation retention m.	Anderson and Tushman, 1990
	Know-how isolating m.	Cattani, 2006
	Founder effect mechanism	Arthur, 1989
	Internal selection mechanism	Bannet and Burgelman, 1996
Firm level	Person-to-person mechanism	Nelson, 1995b
	Routine changing mechanism	Nelson, 1995b
	Lobbying mechanism	Nelson, 1995b
	Resource allocation mechanisms	Gilbert, 2005
	Adaptive learning	Hannan and Freeman, 1977
	Local search	Nelson and Winter, 1982; Nelson and Winter, 2002; Murmann et al., 2003
	Learning mechanism	Hannan and Freeman, 1984; Zollo and Winter, 2002
	Cognitions, ideologically inclined strategy and performance outcomes mediating mechanism	Lamberg and Tikkanen, 2006
	Habit	Hodgson, 2007
Institutions	State control mechanism	Hannan and Freeman, 1977
	Enforcement mechanism	Ingram and Inman, 1996
	Regime transformation mechanism	Geels, 2006
	Mechanism of negative feedback	Holm, 1995
	Mechanisms to enforce law and make new law	Rosenberg and Birdzel, 1986
	Reconstitutive downward causation m.	Hodgson, 2007
	Backward-looking rationalization	Jennings et al., 2007

Thus the most general mechanisms at the industry level are the ‘mechanisms for inducing change’, ‘mechanism to winnow the variation’, and ‘selection mechanisms’ (Nelson, 1995b). For example, Nelson (1995b) used the concept of a mechanism to explain how more productive and profitable techniques replace less productive ones. According to Nelson the outcome was a result of two mechanisms: firms using more profitable technologies will grow, and more profitable technologies tend to be imitated and adopted by firms who had been using less profitable approaches. Furthermore, the concept of a ‘market mechanism’ is widely used to explain the phenomena of how the market sorts out (or selects) the more desirable solutions to problems and suppresses the undesirable ones. Thus, market mechanism can be considered to be one of the master mechanisms in economic change (Schumpeter, 1934).

Second, there are mechanisms that are active within a firm. Nelson and Winter (1982) referred to mechanisms such as ‘local search’ or ‘routine changing mechanisms’ that serve to change the internal routines of a firm. Moreover, Nelson (1995b) mentioned ‘innovation mechanisms’ and ‘person-to-person transmission mechanisms’ as examples of interfirm mechanisms. In the same spirit, Murmann (2003) identified ’internal optimizing mechanisms’ to find out optimal solutions under external selection pressure. Recently, Lamberg and Tikkanen (2006) identified mechanisms that created causal links between the political structure of a firm and ideology and finally to managerial cognition as a basis for competitive advantage in the Finnish retail industry 1945–1995. A further example of using mechanisms to explain the evolution of institutions is Rosenberg and Birdzell’s (1986) study which identified ‘mechanisms to enforce law’ and ‘mechanisms to make new law’.

Third, there are mechanisms that explain a change that can be identified in at a certain level of analysis, but are induced from another level of analysis. Examples of these are the dominant design (Murmann and Frenken, 2006), which causes a ‘rolling snowball’ or ‘self-reinforcing mechanism’ within an industry to take place, and ‘lobbying mechanisms’ (Nelson, 1995c) which result from corporate political activity (Lenway and Rehbein, 1991; Mahon and McGowan, 1998) with a goal to evoke a change in an institutional level. In his empirical study of the synthetic dye industry in Europe at the beginning of the 1900s, Murman (2003) identified three kinds of self-reinforcing mechanisms between the German dye industry and the social institutions that formed the basis for dominance in the industry: exchange of personnel, the formation of commercial ties, and lobbying. In these cases the mechanisms were not one-way, but rather were combined as two-way mechanisms thus forming the basis for the concept of coevolution (Nelson, 1995a). Furthermore, Jennings et al. (2005) identified the impact of shock events such as wars, to have a periodic effect that increases the number of rules and the likelihood of revision in legislation. They suggest that much of the evolution of the British Columbia Water Law involved consolidating and resolving tensions between a set of rules which originated from history. They called this a 'backward-looking rationalization process'[4].

Indeed, understanding the process of change and the influencing mechanisms is at the center of research of economic and organizational change; both during stable circumstances and for periods of external or internal shocks. Most of the mechanisms identified in the existing industry evolution literature are by nature *evolutionary*; they explain the higher level evolutionary processes. The variation, selection and retention mechanisms (Campbell, 1969; Hannan and Freeman, 1977; Nelson, 1995b; Murmann, 2003) are archetypal manifestations of evolutionary mechanisms. However, some of the mechanisms identified in the industry evolution and evolutionary economics scholarly literature are by nature *causal*. For example, Nelson (1995a) used the expression *causal arrow* to describe the process of coevolution. Likewise Murmann (2003) identified several self-reinforcing *causal mechanisms*. Recently, Lamberg and Tikkanen (2006) identified a *causal link* from structure to ideology and finally to managerial cognition, and Lamberg et al. (2008)

[4] The terminology that Jennings et al. (2007) use shows that a common terminology of processes and mechanisms as presented by Tilly (2001) would help the theory development in industry evolution and institutional research –what they called 'processes' are clearly the same constructs as what is called 'mechanisms' in many other studies.

provide a *causal explanation* of competitive behavior in conjunction with the evolution of the firm and its business environment.

It should be noted however that most of the existing evolutionary theories are not causal in the sense that they do not specify the engines driving variation, selection and retention. Instead, many of the current models are algorithmic; specifying that if certain conditions are met, then a particular outcome will occur (Aldrich, 1999). For example, Nelson and Winter (1982) described the evolutionary change process algorithmically as a Markov process. Other examples of algorithmic modeling are the hazard models of industry life cycle developed by Klepper (1996), and the density dependence models of population ecology (Hannan and Carrol, 1992).

Causality, on the other hand, has not received much attention among existing industry evolution research. However, the value of causal explanations is not denied in the literature. On the contrary, many causal explanations are considered to be *compatible* with the underlying evolutionary explanations (Nelson and Winter, 2002; Nelson, 2005). Nelson and Winter (1982) argued that it is a question of two different levels of abstraction. The causal explanations, generally manifested in the form of stories (Nelson, 1995b), are seen as 'appreciative theorizing' (Nelson and Winter, 1982) in contrast to the 'formal theorizing' represented by the algorithmic models. Likewise, more generally in economic explanations, 'covering law' (Hempel, 1965) explanations have dominated. On the other hand, as Runde (1998) argued, causal methods and causal explanations are also viable in economics to provide alternative and *complementary* economic explanations. Understanding the impact of sudden environmental shocks, such as public policy interventions, require different explanations than can be solely offered by evolutionary mechanisms. As Pearl (2000) pointed out, causal effects permit us to predict how systems would respond to hypothetical interventions such as public policy decisions. Such predictions "are the hallmark of causal modeling, since they are not discernible from probabilistic information alone, they rest on – and in fact, define – causal relationships" (Pearl, 2000:65).

Causality has a long tradition for providing explanations in social sciences in general. In the last decade, causality has undergone a major transformation from a mysterious concept to mathematical and graphical models (for a good review see Pearl, 2000). Moreover, the use of mechanisms has evolved in the other areas of social sciences to include rigorous descriptions of the characteristics of mechanisms. Indeed, as recent empirical studies (Murmann, 2003; Lamberg and Tikkanen, 2006; Lamberg et al., 2008) indicate, causal explanations and causal mechanisms are an important complementary component of the evolutionary explanation. The principles of causal explanations in social sciences and the characteristics of mechanisms as presented in other areas of social sciences are reviewed next.

2.2.2. Causal explanations in the social sciences

In much of social sciences the quest is to determine the process through which the assumed cause is related to the outcome (Kendall and Lazarsfeld, 1950). The central goal of this type of investigation is to explain this process between a causal variable X and outcome variable Y.

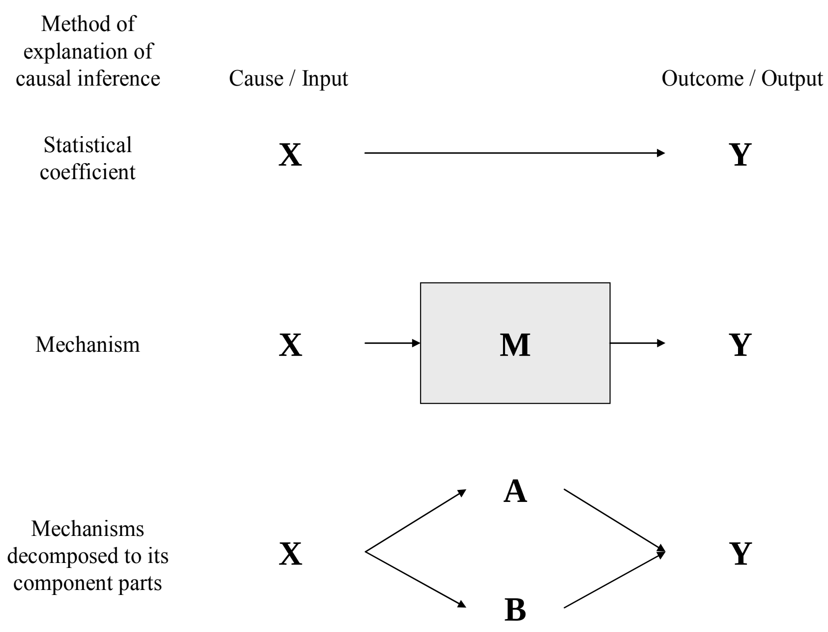

Figure 1: Different methods of causal effects

Adequate explanations for how causes bring about their affects must, at some level, specify in empirically verifiable ways the causal pathways between causes and their outcomes (Morgan and Winship, 2007). The different methods of the causal inference are described in Figure 1.

First, the mainstream method to test and give evidence of causality has traditionally been single-equation statistical models, in which the causes and outcomes are evaluated next to each other and in which the causal influence of the cause X upon the outcome Y is, in the simplest form, simply a regression coefficient. These probabilistic methods, often called ‘black-box explanations’ (cf. Duncan, 1975), have been criticized because they oversimplify the causal relationship (Hedström and Swedberg, 1998; Hedström, 2005; Morgan and Winship, 2007; Durand and Vaara, 2009) and neglect the social science tradition, in which “much of the scientific quest is concerned with the search for intervening variables that will serve to interpret of explain gross associations presumed to reflect a causal relationship” (Duncan et al., 1972). Moreover, from a point of methodological individualism, many sociologists have criticized pure statistical techniques as a method of providing adequate causal explanations in social phenomena (see Goldthorpe, 2001). These kind of explanation just show the relationship between X and Y, not *how* and *by whom* the relationship is produced (Coleman, 1990; Abbott, 1992; Hedström and Swedberg, 1998).

Second, Hedström and Swedberg (1998) argued that the search for *mechanisms* signify that the establishment of systematic covariation between variables or events is not enough; a satisfactory explanation requires that the social 'cogs and wheels' (Elster, 1989:3) that have brought the relationship into existence, should be specified. Thus, the second diagram in Figure 1 represents the view of Hedström and Swedberg (1998), where a *mechanism* provides the inference between the input and the output or between the *explanans* and the *explanandum*. They highlighted the importance of the existence of the *structure* of the link; the mechanism. In essence this is the answer to the questions of *how* and *why*; the *interpretation* and *explanation* of the relationship between X and Y is what mechanisms are all about (Kendall and Lazarsfeld, 1950; Morgan and Winship, 2007).

Third, the last diagram in Figure 1 depicts the decomposing of a mechanism to its component parts. This can be achieved with mediating and intervening variables, as described by Pearl (2000) and by Morgan and Winship (2007). Mechanisms occur in nested hierarchies in which “the lower level entities, properties and activities are components in mechanisms that produce higher level phenomena” (Machamer et al., 2000:13). Thus, the analysis of social phenomena requires that the complex totality is *decomposed* “into its constituent entities and activities” and then “bring into focus what is believed to be its most essential elements” (Hedström, 2005:2).

In addition to the approaches to causality mentioned above, ; which can be called (1) probabilistic and (2) mechanistic accounts of causality, there are three other notable accounts or approaches to causality in social sciences: (3) regularity, (4) interventional, and (5) counterfactual accounts (Reiss, 2009).

Regularity accounts use qualitative comparative analysis (QCA) and Boolean algebra (Ragin, 1998, 2008; Rihoux and Ragin, 2008) to examine macro-social phenomena. In QCA the identification of the causes of a particular phenomenon starts by arranging all observed instances of that phenomenon in a table. Then a list of factors of the phenomenon is constructed, and it is noted whether each factor is present or absent. A factor is judged to be a cause whenever it is a member of a group such that group of factors is always associated with the phenomenon of interest and no subgroup is associated with the phenomenon (Reiss, 2009). Regularity accounts are widely used in sociology (Amenta and Halfmann, 2000), political science (Marx, 2008) and criminology (Williams and Farrell, 1990).

Interventional accounts (Gaskins, 1955; Woodward, 2003) highlight the possible change or manipulation of the cause and the subsequent effect to the outcome. Woodward (2003) calls this a 'what-if-things-had-been-different' question: "the explanation must enable us to see what sort of difference it would have made for the explanandum if the factors cited in the explanans would have been different in various possible ways" (2003:11). Reisman and Forber (2005) build on Woodward's ideas and argue that conducting controlled manipulations is a reliable strategy for identifying causal relations. In their response to Matthen and Ariew (2002) and

Walsh et al. (2002), who argued that evolutionary selection and drift are best understood as statistical trends rather than causes, they show that evolutionary natural selection and random drift can be manipulated to produce different kinds of evolutionary change.

Counterfactual accounts (Lewis, 1973, 1978; Pearl, 2000; Morgan and Winship, 2007) are one of the most dominant models of causation used widely in statistics and economics (Roy, 1951; Quandt, 1972; Heckman, 1974, 1996, 2000), as well as in social sciences (Manski, 1995, 2003, Moore, 1978, Brady, 2003). Recently, Durand and Vaara (2009) proposed the counterfactual approach as an explanatory tool for strategy research. They offered two methodologies, counterfactual history and causal modelling as solutions for providing explanations in strategy research.

The counterfactual approach is also rooted in philosophy. In the philosophical tradition, initiated by Lewis (1973, 1978), the counterfactual dependence between two events X and Y is defined so that X causes Y if X and Y both occur and if X had not occurred and all else remained the same, then Y would not have occurred. Woodward (2003), building on Lewis' (1973) definition and the work of Pearl (2000) takes the definition further and includes the values or characteristics of X and Y to the notion of counterfactuals. According to Woodward there is a counterfactual causal relationship between X and Y, if and only if an intervention on X (that changes the characteristics of X) would change the characteristics of Y and the relationship would remain invariant.

Counterfactual and interventional accounts are philosophically similar in the sense that in seeking the causes of an event the focus is on alternative options. However, where interventional accounts pay attention to the manipulation of the explanans, counterfactual research is seeking answers to questions of what would have happened if the preceding event had not occurred (Griffin, 1993; Abell, 2001; Pajunen, 2004).

Causation has two faces; *necessary* and *sufficient* (Pearl, 2000). The fundamental counterfactual definition of causation captures the notion of *necessary* cause. In order to identify law-like 'general causes' (and related mechanisms), all factors should be known, all relevant details should be spelled out and nothing should be left to chance or guessing (Pearl, 2000). In general, however, this is in practice never the case. Especially in historical analysis the "real history" with all its facts and details is neither known nor knowable (Griffin, 1993). As Weber (1949) argued, a 'concrete event' (p. 165) is too complex to subsume under causal generalizations or theoretical laws. The extension of the counterfactual notion to also include the *sufficient* component of causation is important in order to be able to identify the *actual causes*[5] (Pearl, 2000:309) and the representations of the mechanisms. This parallel notion of causation has been used, for instance in policy analysis (Khoury et al. 1989), to identify the sufficient or threshold level of certain characteristic of an event to cause an effect in a population. Counterfactual reasoning can be used as a supportive tool to identify the relevant events (Moore, 1978), the actual causes and the representations mechanisms between the events. Although in most cases we possess only partial information of the research subject, "the more episode-specific evidence we gather, the closes we come to the ideals of token[6] claims and actual causes" (Pearl, 2000).

The search for general causes (Pearl, 2000) leads to covering-law explanations. However, as Mayntz (2004) emphasized, laws are basically general statements of covariation and they point out causal factors, not *processes*. For this reason, in social sciences, in order to avoid a search for social laws, social mechanisms are used as building blocks of middle-range theories, advocated by Merton (1957), to explain social processes.

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[5] Pearl (2000) makes a notable distinction between *actual causes* and *general causes*. According to Pearl, statements like "a car accident was the cause of Joe's death" represent a single-event statement and an *actual cause*. On the other hand statements of the type "car accidents cause deaths" when made relative to a type of events or a class of individuals may be classified as *general causes*.

[6] In Pearl's (2000), terminology *token* equals *singular* or *single-events,* which represent *actual causes* in contrast to *generic* or *type-level events,* which represent *general causes.*

2.2.3. Identification of mechanisms and causal diagrams

The identification of mechanisms from empirical data is challenging because most mechanisms do not have names that can be found in common everyday language. As Pearl (2000) pointed out; "complex descriptions of…how mechanisms interact with one another are rarely communicated explicitly in terms of mechanisms. Instead, they are communicated in terms of cause-effect relationships between events and variables" (2000:225-226). Bhaskar (1978) argued that the world consist of mechanisms, not events. Although he admitted that "it is rarely that they [mechanisms] are actually manifest and rarer still that they are empirically identified by men" (1978:34), he urges science to generate knowledge of mechanisms that "produce the phenomena of the world".

The dilemma of the fact that mechanisms are on the other hand key concepts of explanation in social sciences, but on the other hand are challenging to identify, has been lifted up in the philosophy of science discourse. For instance, Bunge (2004:200) argued that "there is no method, let alone logic, for conjecturing mechanisms…one reason is that, typically, mechanisms are unobservable, and therefore their description is bound to contain concepts that do not occur in empirical data", but concludes that "no law, no possible mechanism; and no mechanism, no explanation" (2004:207).

Being aware and respecting the philosophical challenge of identifying mechanisms, several scholars have seized the challenge presented by Bhaskar (1978) to identify mechanisms from empirical phenomena. Goldthorpe (2001) proposed a three-phase process of causal analysis: establishing the phenomena that form the explananda, hypothesizing generative processes (or mechanisms) at the level of social action, and testing the hypothesis. Following the logic of Goldthorpe (2001), Glennan (2005) offered the concept of a *mechanical model* to link real world phenomena and mechanisms. A mechanical model consists of two parts; a description of the mechanism's behavior (a behavioral description), and a description of the mechanism that accounts for that behavior (the mechanical description). The behavioral description deals with real life events and describes what a mechanism is doing, while the mechanical description deals with a theoretical tells one how the mechanism does it. The division between the behavioral description and the mechanical description is analogous to the division between explanandum and explanans (Hedström and Swedberg, 1998). However, it should be noted that what emerge from mechanistic explanations are not the organizational mechanisms per se, but models of mechanisms which are operative in the organizational processes (Pajunen, 2008).

Methodologically, *causal diagrams* provide a useful tool for combining empirical (event based) data with causal information and thus performing and presenting the analysis and the mechanistic explanations. Causal diagrams are helpful both to describe the behavioral description; the chain of events, and the mechanical description; the component parts of the mechanism. The process of identification of a mechanism "begins from an initial condition or setting that may be, and usually is, the result of preceding processes and mechanisms, but can be idealized as a static situation, and ends with an end condition or outcome that may, for example, be the state of affairs that we are trying to understand" (Pajunen, 2008:1454). The causal diagram is therefore not only a tool for presentation; it may also be used as a tool to identify the mechanisms that are active during the period of investigation. The graphical identification of causal mechanisms and their characteristics fit well together with the statistical and descriptive analysis; they are not exclusive methods but complement each other (Mayntz, 2004). Or as Steel (2004:71) put it: "without the aid of statistical data, the best one can hope to establish by means of process tracing is purely qualitative causal claims".

Causal diagrams are based on graph theory (Harary et al., 1965; Hage and Harary, 1983) with di-graphs (Abell, 2004) with *nodes* and *arrows* (or arcs) as basic elements. The nodes represent the phenomena and the arrows the causal relationship between the phenomena (Laukkanen, 1994). There are several examples in the scholarly literature of distinct methodologies using causal diagrams.

First, *directed graphs* or directed acyclic graphs (DAGs) (Pearl 1995, 2000) have been extensively used in the engineering, computer and medical sciences, and also in social sciences (Morgan and Winship, 2007) to represent causal or temporal relationships.

Second, *causal maps* (Ross and Hall, 1980; Eden et al., 1992; Nadkarni and Shenoy, 2001), also called *cognitive maps* or *cause maps*, have been widely used in the areas of policy analysis (Axelrod, 1976) and in organization and management research. They have been used as tools to facilitate decision making and problem solving within the context of organizational intervention (Eden, 1992; Laukkanen, 1994, 1996). Moreover, (Klein and Cooper, 1982) used causal maps to examine the causal belief systems of decision-makers, their behavior and perceptions.

Third, *event-structure analysis* (ESA) (Heise, 1988, 1989; Griffin, 1993) and the related ETHNO software were developed to link narratives to causal inference. The method was used by Griffin (1993) to analyze lunching in Mississippi in 1930. Stevenson and Greenberg (2000) used event-structure analysis to explain the success and failure of actors in a network of relationships who were trying to influence policies on environmental issues in a small city. Uehara (2001), in turn, utilized the method to explain the dynamics of illness and help-seeking in a Cambodian-American family. In addition, Pajunen (2004) examined three organizational decline and turnaround processes in the Finnish pulp and paper industry and Pajunen (2008) analyzed the decline and failure process of the Finnish conglomerate Tampella using event-structure analysis. The analytical core of ESA is the temporal ordering and sequencing of action, rather than historical scope (Griffin, 1993). Fourth, building on the sequence methods (Abbott, 1990, 1995), Abell (2004) offered a graphical presentation of a historical narrative in the form of a di-graph. In the graphs the nodes are states of the world and the arcs are actions of actors, who are either individual or collective.

2.2.4. Key characteristics of mechanisms

Productive behavior, component parts and hierarchical structure

Mechanism as a concept has been broadly used in social science and philosophical literature to explain processual phenomena (Bechtel and Abrahamsen 2005; Bennet and George, 1997; Elster, 1989; George and Bennett, 2005; Glennan, 2002; Hedström and Swedberg, 1998; Hedström, 2005; Little, 1991; Machamer et al., 2000; Mahoney, 2001; Pajunen, 2004, 2008; Stinchcombe, 1991). In recent years there has been a more systematic approach to this area of research. A summary of the major definitions of mechanisms in the existing scholarly literature is presented in Table 3.

Table 3: Definitions of mechanisms in the social science scholarly literature

Presented by	Definition of Mechanism
Bechtel and Abrahamsen, 2005:423	A mechanism is a structure performing a function in virtue of its component parts, component operations, and their organization. The orchestrated functioning of the mechanism is responsible for one or more phenomena.
Bennett and George, 1997:1	The processes and intervening variables through which causal or explanatory variables produce causal effects.
Elster, 1989:3	Nuts and bolts, cogs and wheels –that can be used to explain quite complex social phenomena.
Glennan 2002:344	A mechanism for a behavior is a complex system that produces that behavior by the interaction of a number of parts, where the interactions between parts can be characterized by direct, invariant, change-relating generalizations.
Hedström and Swedberg, 1998:45	Mechanisms are frequently occurring and easily recognizable causal patterns that are triggered under generally unknown conditions or with indeterminate consequences
Little, 1991:15	A causal mechanism, then, is a series of events governed by law-like regularities that leads from the explanans to the explanandum.
Machamer et al., 2000:3	Mechanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions.
Mahoney, 2001:580	A causal mechanism is an unobserved entity that—when activated—generates an outcome of interest.
Tilly, 2001:25-26	Mechanisms form a delimited class of events that change relations among specified sets of elements in

The definitions recapitulate well the key characteristics of mechanisms (see Pajunen, 2008). Thus, based on the existing body of knowledge, the three important characteristics of mechanisms can be summarized as follows:

1. Mechanisms explain a *causal connection* between events or phenomena,
2. Mechanisms consist of their *component parts* and their *activities*, and
3. Mechanisms have a *hierarchical structure* and operate across multiple levels of analysis.

First, mechanisms have a productive behavior – they cause events or phenomena to occur (Coleman, 1990; Machamer et al., 2000; Glennan, 2002). According to Hedström and Swedberg (1998) mechanisms are constructs that provide explanation on how and why an output of social phenomenon is caused by a particular input. Thus mechanisms are the constructs to open the ‘black-box’ between observed events or phenomena and are often considered to be the building blocks of middle-range theories (Merton, 1957; Mayntz, 2004).

Second, mechanisms consist of their component parts (Bechtel and Abrahamsen, 2005). In mechanistic explanations one is looking not just at what the system is doing, but also 'into the system' at how it is doing what it is doing (Vromen, 2008). The component parts form a complex system with interaction between the components (Glennan, 2002). Or, to look it from the whole-part viewpoint as Hedström (2005) does, the total can be dissected to its component parts.

Third, a further important characteristic of the component parts of mechanisms is that they are organized hierarchically (Bechtel and Abrahamsen 2005; Machamer et al., 2000; Stinchcombe, 1991). The lower level components together activate the mechanism as a whole, or at a higher level (Pajunen, 2008). This spatial organization of the components is of obvious importance for biological mechanisms, such as those presented by Machamer et al. (2000). However, the spatial role has not been systematically discussed in the social sciences (Mayntz, 2004), except for a few exceptions (cf. Pajunen, 2004, 2008). One reason for this is different assumptions and subsequent tension between methodological individualists and collectivists (Bunge, 2000; Pajunen, 2008). For example, Vromen (2008) criticized the impact of individuals in social macro-micro phenomena presented by Felin and Foss (2007) and argued that individuals, their properties and their actions and interactions are not related to the causal relationship between the macro and micro levels of analysis. Rather, for Vromen, they are constitutive component parts of the macro phenomena. Similarily, Durand and Vaara (2009) argued that even if social actors are able to trigger or hinder the actualization of social mechanisms, cannot change the causal mechanisms per se, but they can influence the conditions of the social phenomenon in question and consequently the outcome of the mechanisms.

Despite the different views of methodological individualism and collectivism it is clear that the internal structure of a mechanism should be differentiated from a causal chain of events and the effect of multiple active mechanisms. Craver and Bechtel (2007) do this by distinguishing between etiological and constitutive explanation. The etiological mechanistic explanation aims to explain how some final or terminal condition of a system is brought about by the working of a mechanism which is activated (or triggered) by some start or set-up conditions. The constitutive mechanistic explanation aims to show how the mechanism works internally. Craver and Bechtel (2007) argue in particular that the relation between the entities identified at adjacent levels in mechanistic explanation is not a causal one (Craver and Bechtel 2007). Thus, for them levels relate to each other as wholes to their component parts, not as causes and their effects.

Bunge (2004) suggested that a distinction be made between the internal spatial structure of a mechanism and the mechanisms between the macro and micro levels of analysis. This can be achieved by labeling the latter mechanisms, such as the effect of institutional events (for example commercial codes and government regulations) *metamechanisms*. Bearing in mind the difference, as the focus of this study is precisely on these kinds of metamechanisms, I have chosen to simply call them *mechanisms*.

Evolutionary and emergent mechanisms and the role of agents

In the industry evolution tradition the nature of mechanisms is often considered to be *evolutionary*, and the impact of individuals is often considered to be leveled off (Nelson and Winter, 1982). These kinds of mechanisms can be compared in grammatical terms with sentences, in which there is no subject and the verb is in the passive. In these cases the related mechanisms are *emergent* by nature (Nelson, 1995b; Lewin et al., 1999; Murmann, 2003; Murmann and Frenken, 2006).

In the scholarly literature the philosophical notion of *emergence* (Sawyer, 2001) is often used together with the micro-macro link (Alexander et al. 1987; Coleman, 1990). Lewes (1875) distinguished two types of causal effects: resultants and emergents. According to Lewes an emergent effect is not additive, not predictable from knowledge of its components, and not decomposable into those components (Lewes, 1875). Scholars who represent methodological collectivism use the concept of emergence to argue that collective phenomena are collaboratively created by individuals, but are not reducible to explanation in terms of individuals (Archer, 1979; Bhaskar, 1978). On the other hand, emergence as a concept has also been used by methodological individualists, who accept the existence of emergent social properties, but argue that they can be reduced to explanations in terms of individuals and their relationships (Axelroad, 1997; Coleman, 1990). Whereas methodological collectivists propose that the micro level social properties are results of the macro level causal laws through a process of downward causation, methodological individualists only emphasize the emergence of macro level properties from the micro level (Sawyer, 2001; Hodgson, 2007). However, it is notable that both sets of scholars agree on the empirical importance of analyzing the *temporal mechanisms of emergence* (Sawyer, 2001).

On the other hand, several scholars have highlighted the importance of *causal agents* (Bhaskar, 1978) and their *agency role* (Durkheim, 1982) in inducing mechanisms. Machamer et al. (2000), for example, pointed out that the component parts consist of *entities* and *activities*; activities are the producers of change, entities are the actors engaged in activities. According to Hedström and Swedberg (1998) agents generate the relationship between the entities being observed. They argued that “it is by explicitly referring to these causal agents that the relationship is being made intelligible” (Hedström and Swedberg, 1998:11). In the organizational change literature the role of agents in change is also clearly identified. For example, Schumpeter (1955) highlighted the difference between the outcome of the actions of ‘mere managers’ and ‘entrepreneurs’. According to Schumpeter, the entrepreneur is the leader who is ‘carrying out of new combinations’ and thus causes different outcomes for the firm. On the other hand, there are only small variations in the outcomes of the ‘mere managers’.

Similarly, Lewin et al. (1999) identified the role of managerial actions in the coevolution of new organizational forms. North (1990:104), in turn, highlighted the role of actors in long-term economic change, which is “the cumulative consequence of innumerable short-run decisions by political and economic entrepreneurs that both directly and indirectly (via external effects) shape performance.” Recently, Winter (2006) emphasized the difference of outcomes when routines are performed by different people. Durand and Calori (2006) underlined the role of ‘powerful agents’ within the organization as potential conveyors of organizational change or, as they call it, ‘otherness’ in comparison to ‘sameness’ of other organizations. Moreover, according to Hodgson (2007) there is a two-way causal impact between institutions and individuals. Institutions depend for their existence upon individuals, and it is sometimes possible for individuals to change institutions. In addition, institutions can involve downward causation to change the dispositions and behaviors of the agents through a mechanism of ‘habituation’.

There are two interesting characteristics of the agents with regard to their actions: (1) the intentionality (Aldrich, 1999; Lewin and Volberda, 1999) of the actors and the consequent *purposive actions* (Granovetter, 1985), and (2) the effect of *desires* and *beliefs* (North, 2005; Hedström, 2005) in connection with the available *opportunities* as causes of an action. Aldrich (1999) distinguishes two kind of variation; intentional and blind. According to Aldrich "intentional variations occur when people or organizations actively attempt to generate alternatives and seek solutions for problems" (1999:23). In contrast, blind variations, "occur independently of environmental or selection pressures" (Aldrich, 1999:23). Indeed, as Durand and Vaara (2009) argue, the socials actors' interpretations of the situation affect their actions and can trigger or hinder the actualization of causal mechanisms, leading to expected or unexpected effects to the social phenomena in question.

Volberda and Lewin (2003) build on Baum and Singh (1994)[7] and distinguish between macro-evolution (the external selection environment of an organization), and micro-evolution (the internal selection environment of an organization). For these authors, the intentionality of the agent may be identified in micro-evolution and the subsequent effects in macro-evolution are results of the co-evolution between the micro and macro levels.

The two-way interaction between an agent and the environment (Hodgson, 2007) is also emphasized by Granovetter (1985:487) as he argues that "actors do not behave as atoms outside the social context, nor do they adhere slavishly to a script written for them by the particular intersection of social categories that they happen to occupy. Their attempts at purposive action are instead embedded in concrete, ongoing systems of social relations." The purposive actions highlighted by Granovetter (1985) manifests an important characteristic of agents: their intentionality. The intentionality of agents enables us to explain an action by reference to the future state it was intended to bring about (Hedström, 2005). The DBO (Desires, Beliefs and Opportunities) theory[8] introduced by Hedström (2005) enables the actions of an agent to be explained by preceding mental events (desires and beliefs) and the available alternative actions that exist independently of the agents beliefs about them. The DBO theory provides a useful tool to disclose the mediating and intervening events (desires and beliefs) and variables (opportunities) and thus explain the component parts of a causal connection.

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[7] Baum and Singh (1994) make a distinction between genealogical hierarchy and ecological hierarchy.

[8] According to Hedström (2005), a *belief* is as a proposition about the world held to be true, a *desire* is a wish or want, and *opportunities* describe the 'menu' of alternative actions available to the actor.

Macro-micro link and mechanisms

Coleman (1990) highlighted that mechanisms are constructs that explain the causal connection between the component parts – and particularly between the component parts at the *macro* and *micro* levels of analysis (Alexander et al. 1987; Coleman, 1990). Thus the ‘real structure of the world’ is represented by the microphysical causal structure, whereas the higher macro-level represents the social or business explanation (Glennan, 2002). Theoretically, the lower level combination of events describes why the outcome at the higher level that is produced by the mechanism is true (Machamer et al., 2000; Pajunen, 2008). Such an explanation of a particular event or phenomenon in the macro level of analysis is often also found in the micro level of analysis (Hedström, 2005). According to Hedström and Swedberg (1998), the transitions between the macro and micro levels can be explained with three key mechanisms: (1) situational mechanisms describe how the macro-level events or conditions affect the micro-level, (2) action-formation mechanisms characterize how the micro level – organization or individual – assimilates the impact of the other micro-level events or conditions, and (3) transformational mechanisms define how micro level actions and events generate the macro level outcomes. The transition between macro and micro levels of analysis (Coleman, 1990) and the distinct mechanisms presented by Hedström and Swedberg (1998) are depicted in Figure 2.

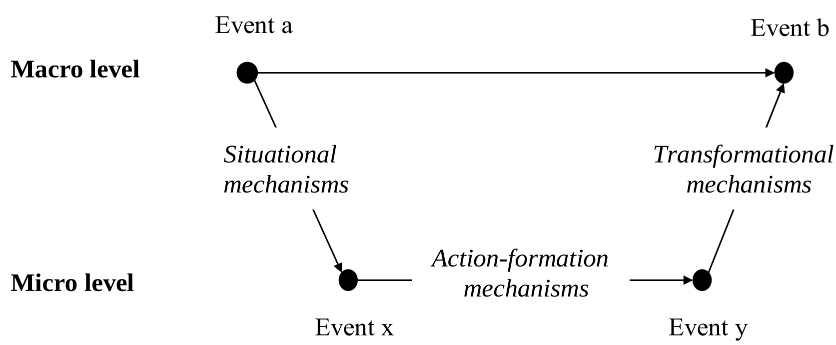

Figure 2: Mechanisms that operate between the levels of analysis

Mechanisms are used to explain the change between different levels of analysis such as those between society and social systems (Coleman, 1990), between social systems and individuals (Hedström and Swedberg, 1998) or between *multiple levels of analysis* (Baum and Powell, 1995; Dansereau et al., 1999; Geels, 2002, 2005, 2006; Lepak et al., 2007). For example, Lepak et al. (2007) used a multi-level approach to explain the sources of new value creation between levels of society, organizations and individuals. They identified two key mechanisms; competition and isolation, which operated across all levels of analysis and which explained the connection between value creation and value capturing. In addition, Geels (2002) used a multi-level approach to explain how technological transitions occurred in the transition from sailing ships to steamships during the years 1780-1900. His framework consisted of phenomena at three levels; (1) a 'micro'-level of technological niches, (2) a 'meso'-level of sociotechnical regimes, and (3) a 'macro'-level of sociotechnical landscapes. He successfully utilized similar multi-level approaches in proceeding consequent case studies: the transition from horse-drawn carriages to automobiles from 1860–1930 (Geels, 2005), the transition from cesspools to sewer systems during 1840–1930 (Geels, 2006), the Dutch electricity system between 1960–2004 (Verbong and Geels, 2007), and the breakthrough of rock 'n' roll during 1930–1970 (Geels, 2007).

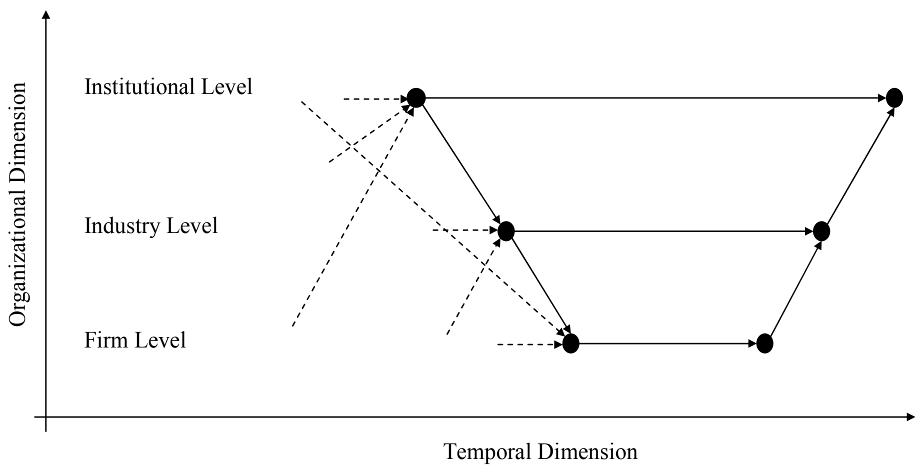

Figure 3: Interaction between the mechanisms

Indeed, since long-term change occurs in a complex multidimensional space, the mechanisms in a framework to analyze long-term change processes should include not only mechanisms between two adjacent levels, but a chain of events or a causal pathway (Lamberg et al., 2008) between all the selected levels of analysis. The representation of mechanisms depicted in Figure 3 is an illustration to elucidate the causal history and its effects on the macro-micro phenomenon. In the empirical analysis, the key assignment is to identify all the *relevant* events that have a causal impact on a particular event at the selected level in order to be able to provide a logically consistent explanation (Glennan, 2007; Hedström, 2005).

2.2.5. Mechanisms behind coevolution and path dependence

Two important evolutionary concepts – coevolution (Chandler, 1990: Nelson, 1995b; Murmann, 2003) and path dependence (Nelson and Winter, 1982, Puffert, 2000, 2002; Cattani, 2005, 2006) have been used as explanations of empirically observed evolutionary phenomena at the *process level* of the temporal scope of analysis. However, in order to get an answer to the question of *how* and *why* coevolution and path dependence occur, the temporal scope of analysis needs to focus on mechanisms. In the next section coevolution and path dependence are presented in the light of existing scholarly literature. Thereafter they are unpacked to their component parts by making use of mechanisms.

Coevolution

March and Simon (1993), in the introduction to the second edition of their seminal (1958) book, ‘Organizations’, stated that looking at their early work 35 years later they would now have taken greater account of the role of the historical context of organizations. They identified *coevolution* as a key concept for explaining change both within a firm and in its environment: “processes within an organization shape the external world even as it is being shaped by that world” (1993:17). Indeed, the interaction between different levels of analysis in the organizational dimension of existing evolutionary theories is clearly not one-way. The concept of coevolution therefore describes situations in which organizations and populations not only respond to the environmental changes but also affect their environments (Nelson

1995a, Aldrich, 1999).

Strategy and organizational change research has evolved towards two distinct streams of study depending on the emphasis and presupposition of the key source of organization success and survival. This has resulted in an adaptation-selection debate (Baum, 1996). While organizational ecology theories focus on selection and the Variation-Selection-Retention (VSR) process, strategic management theories focus on firm-level adaptation. This has led to distinct levels of analysis, competing theoretical formulations and missing shared definitions (Lewin and Volberda, 1999). On the other hand, Lewin and Volberda (1999) argue that adaptation and selection are not wholly opposing forces, but are fundamentally interrelated and offer co-evolutionary framework as a bridge between the two approaches to explain the mutation process of the existing stock of organizations and to integrate the micro- and macro-level evolutionary explanations. Accordingly, they emphasize that studies of coevolution should include multiple levels of analysis and explanation with multidirectional causalities, feedback loops and path dependence. As they point out, the multilevelness of co-evolutionary research also enables incorporating changes occurring at the level of different institutional systems and economic, social and political macroenvironment of an industry and an organization.

Building on the framework presented by Lewin and Volberda (1999), Volberda and Lewin (2003b) identified four co-evolutionary generative mechanisms that explain the nuances between the changes based on pure evolutionary selection and managerial intentionality. A *Naïve selection* mechanism is active in cases with blind market selection, whereas a *managed selection* mechanism explains situations in which the market selection is impacted by managerial adaptation. *Hierarchical renewal* and *holistic renewal* mechanisms, on the other hand, explain purposeful change processes of organizations that are led by the management.

Coevolution is widely used in the scholarly literature to (1) understand the interplay between institutions and industries (Ingram and Inman, 1996), and between technology, institutions and industries (Nelson, 1995a, 2002, 2005; Murmann, 2003), (2) between competitors within industries (Barnett and Hansen, 1996) or (3) to explain the evolution of the capabilities within a firm (Zollo and Winter, 2002). In the traditional definition of coevolution (Chandler, 1990: Nelson, 1995b) two items evolve simultaneously, each affecting the other's evolution. Abrahamson and Fairchild (1999) brought an important element to the definition – causality; they call coevolution a 'reciprocal causation' process. Murmann (2003) sharpened the definition of coevolution as follows: "two evolving populations coevolve if and only if they both have a significant causal impact on each other's ability to persist" (2003:22).

Nelson (1995a) used lower level concepts such as a 'causal arrow' and a 'mechanism' to describe how the process of coevolution works. On the other hand, Murmann (2003) used concepts such as 'causal links' and 'mechanisms'. However, they both highlight two important characteristics of coevolution. First, coevolution is a relationship between two entities. Second, the relationship can be deconstructed to events with causal connection and direction of impact. These characteristics are fully in line with the characteristics of mechanisms presented earlier. Coevolution is a typical higher level abstract phenomenon, in which the outcome can be identified at a higher level of analysis, whereas the lower level combination of component parts explains exactly how the outcome was produced (Pajunen, 2008). Thus, by means of the mechanisms and different levels of analysis, the microfoundations of coevolution can be explained. This kind of 'unpacking' of a higher level concept will give more understanding of *why* coevolution takes place. The concept of coevolution can be unpacked with use of the mechanisms and the multiple levels of analysis. It applies both for cases in which (1) two levels of analysis or (2) two parallel populations are coevolving.

First, coevolution is often illustrated as a feedback loop between the events at the different levels, thus creating a self-reinforcing process (Young, 1928). Consequently there is a 'two-way causal arrow' between the two observed phenomena. Accordingly, this kind of representation makes it hard for explanatory purposes to clarify why the coevolution occurs. However, using the concept of a mechanism, the two-way arrows can be unpacked to create one-way arrows and the event unpacked to its component parts in the temporal dimension, as illustrated in

Figure 4. Thus, instead of depicting coevolution as one process between two levels of analysis, it can be unpacked to several mediating events and detailed mechanisms between the events. Second, in case when two parallel populations coevolve, the macro-micro-link depicted in Figure 2 attains a second organizational level dimension with mechanisms acting between the events in different industries; as illustrated in Figure 5.

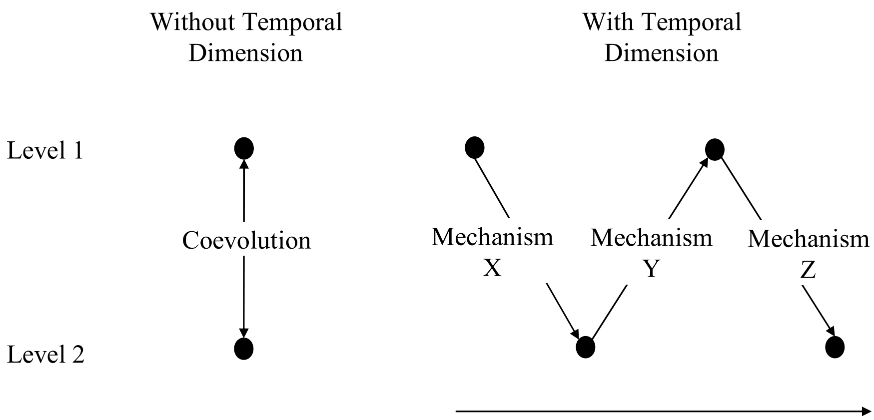

Figure 4: Unpacking the concept of coevolution with mechanisms

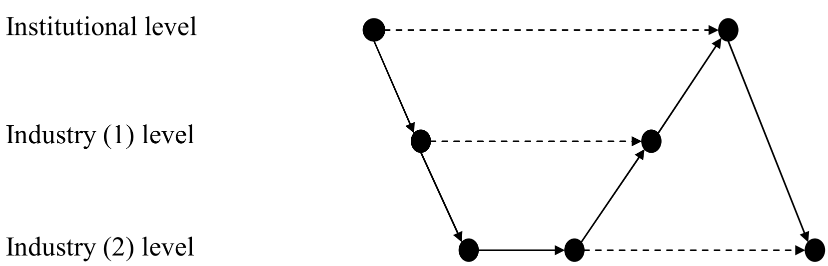

Figure 5: Mechanisms in coevolution of two parallel industries

Path dependence

In addition to coevolution, another important phenomenon in long term change is path dependence. Path dependence is also a key characteristic of industry evolution so that "each time period bears the seeds of its condition in the following period" (Nelson and Winter, 1982). During the process of aging, firm characteristics, or more specifically the assets and capabilities of a firm evolve and accumulate during the trajectory of a firm (Dierickx and Cool, 1989). Moreover, the decisions rules are viewed as being descended from the history of the firm, which is a source of path dependence for firms (Nelson and Winter, 1982). The accumulation of firm-specific capabilities makes it impossible for the system to return to earlier branch points and 'reconsider' (Nelson and Winter, 2002). Under some conditions path dependence is seen as a constricting element compared to an optimal behavior of a particular firm and consequently having a negative impact on the survival of the firm. Puffert (2002), for example, argued that path dependence arises when either foresight (or information) is lacking or else externalities prevent the sorts of behavior that could direct an allocation process toward an optimal outcome.

However, path dependence can also be seen positively. Cattani (2005:564) developed the notion of *technological preadaptation* as "the firm's accumulation, without anticipation and foresight of subsequent uses, of skills and knowledge" and also provides empirical evidence for his theoretical statements in his research of fiber optics industry (Cattani, 2006). All in all, the existing research widely agrees that the historical paths of firms have a substantial effect on firm performance (Mitchell, 1991; Carrol et al., 1996). Moreover, historical paths may have significant impacts at the industry level. The classic example of the QWERTY typewriter keyboard (David, 1985) shows that the absence of a perfect future market drove the typewriter industry to prematurely standardize the 'wrong system'. In addition, Puffert (2002) showed that early choices and the followed sequences of contingent events led to different standards in regional railway gauges and further to inefficiency in the industry.

Path dependence is also a key explanatory phenomenon behind the studies of *industry life cycles* (Klepper, 1997) and in particular incidents of an industry shakeout. These studies provide evidence that firms' experiences prior to entry to an industry – as a result of path dependence – affect their survival and market share in the new market. Klepper and Simons (2000a), for example, investigated how the backgrounds of entrants affect their performance and the evolution of the market structure. In their research on the US television receiver industry they found that pre-entry experience, a firm's innovation in research and development, and the heterogeneity among entrants, contributed most to the industry's shakeout and the evolution of an oligopolistic market structure. A contrary perspective is that put forward by Christensen et al. (1998) who suggested that pre-entry experience can be harmful for a firm committed to a technology that is rendered obsolete in the emergence of a dominant design.

How could the microfoundations of path dependence be conceptualized? The definition put forward by Puffert (2002) gives a good foundation. He defined economic path dependence as an "economic process is one in which specific contingent events – and not just fundamental determinative factors like technology, preferences, factor endowments, and institutions – have a persistent effect on the subsequent course of allocation" (2000:282). That definition summarizes the key characteristics of path dependence: (1) it happens over time, (2) it includes a set of events, which (3) have an outcome. Thus, path dependence can be conceptualized as a result of a *complex chain of causal mechanisms* acting between multiple events and levels of analysis. In some cases the whole chain is important to discover why something happens – in other cases there is only one of few mechanisms that are essential to the outcome (Hedström, 2005), the rest build up a 'snowball effect' (Nelson, 1995b).

2.3. Research motivation

Based on an examination of the findings of the existing research and prevailing theories, as reviewed in the previous chapters, four key conclusions can be made:

1. *Mechanisms* are useful and valuable constructs to present a fine-grained evolutionary explanation behind high-level change processes in order to provide an explanation of how and why the change happened.
2. *Causal explanations* (and causal mechanisms) are required as complementary components to provide a full evolutionary explanation of long-term change.
3. Using *causal diagrams* as representations of causal mechanisms is a practicable method to provide the causal explanation.
4. In order to be able to give causal explanations in evolutionary research, *multiple levels of analysis* are needed.

In this research, these conclusions lead to the central research problem: *"what are the causal and evolutionary mechanisms that explain firm survival or death in a regulated industry?"* In order to find the answers to the research problem, I first build an extensive *research framework* which is presented in detail in the next chapter. I then review thoroughly the distinct components of the research framework based on the existing industry evolution and evolutionary economics literature. Based on the findings of the review I thereafter derive three *research questions*. On the basis of the research questions I then perform a detailed review of the existing scholarly literature of the electric power industry. This review leads to three research propositions, which I scrutinize in the historical analysis of the electric power industry in Finland between 1889 and 2005.

3. RESEARCH FRAMEWORK

3.1. Key elements of the research framework

Figure 6 illustrates the model of the process that leads to a specific industry structure and to changes in the industry structure such as shakeouts and then further to organizational survival or death.

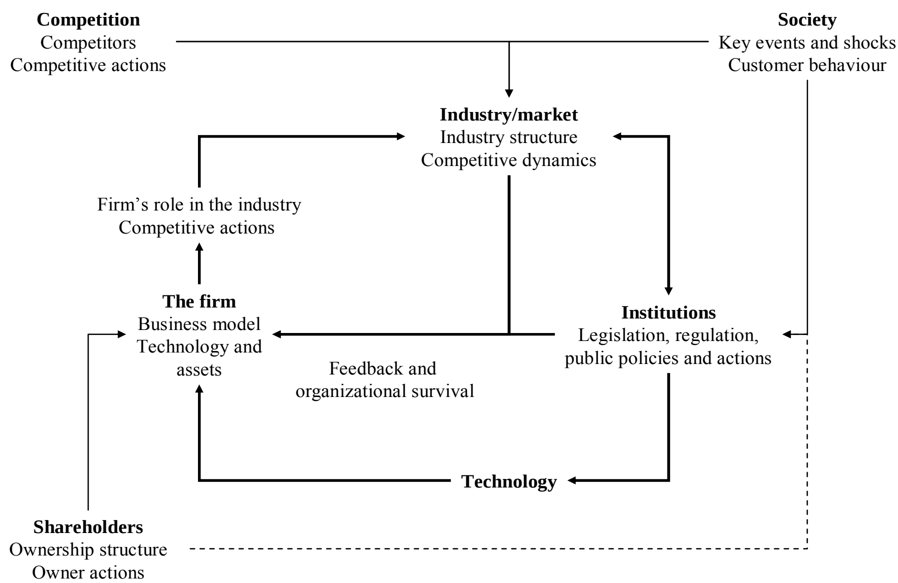

Figure 6: Research framework

The key focus in evolutionary theories is the relationship between the organization and its environment; evolutionary processes shape the organization to fit the environment (Campbell, 1969), and the evolution itself happens at the population or industry level. Consequently, evolutionary theory is inherently a multilevel theory; it requires at least two levels of analysis, the level of organizations or firms that reproduce the differential rates, and the population or the industry level, where the evolutionary change is identified.

Table 4: Distinct organizational levels of analysis

Organizational Level of Analysis	Focus	Research
Society	Society, world economy	North (2005) Government (Jacobides, 2005)
Institutions	Law, regulation, rules	Institutions as the underlying determinant of the long-run performance of economies (North, 1990) Institutional theory (DiMaggio and Powell, 1983, 1991) Evolutionary economics (Nelson, 1986, 1995b, 2005; North, 1990) Evolution of laws (Jennings et al. (2007) Regulation (Joskow, 1996) Knowledge, institutions and competitive advantage (Murmann, 2003) Structuration process between institutions and actions (Barley and Tolbert, 1997)
Population of organizations	Industry	Population ecology (Hannan and Freeman, 1977) Industry life cycles (Klepper, 1997)
Organization	Firm	Transaction cost economics (Williamson, 1971) Firm routines (Nelson and Winter, 1982) Resource dependence (Pfeffer and Salancik, 1978)
Microfoundations of firm	Individuals	New approaches in organizational learning (Felin and Hesterly, 2007) Institutions and Individuals: Interaction and Evolution (Hodgson, 2007) The role of agents (Durand and Calori, 2006)

The distinct elements of the research framework represent different levels of analysis in the industry evolution tradition. It should be noted that the question of a right level of analysis in evolutionary research differs between scholars and between perspectives (Aldrich, 1999)[9]. Table 4 summarized the distinct levels of analysis, their focus and key studies within the strategy and management literature. The key elements of the framework are (1) industry and the market, (2) institutions in the form of legislation, regulation, public policies and actions, (3) the available technology, (4) and the firm and its business model, technology and assets. The framework also includes the relationships with the surrounding society, competitors and firm specific shareholders. I explicate the conceptualization in the following chapters, resulting in three research questions.

3.1.1. The industry and the market

An industry and its related firms form the macro-micro relationship of industry evolution studies. The evolutionary change is identified at the level of the industry, whereas the explanatory factors may typically be identified at the level of the firm. A notably field of research that focuses on the industry is *industry life cycle* research. This field is interested in explaining the driving forces of shifts in market structure. The key assumption is that competitive dynamics in a market environment cause the market conditions to change and consequently cause the number of firms that enter or exit the market to change. A summary of the existing studies of industry life cycles – both studies of entire life cycles of industries from birth to death of an industry and studies of a specific episode during the life cycle of an industry is presented in Table 5.

During a typical industry life cycle the number of firms sharply falls after a long period of steady growth and industries develop into oligopolies. Early studies on this area, such as Utterback and Abernathy (1975) and Abernathy and Utterback (1978) highlight the impact of *technology* in the form of dominant design. Their argument is that those firms that are not able to produce efficiently within the dominant design

[9] See a thorough review in Aldrich (1999) of how six perspectives on organizations – population ecology, institutional theory, organizational learning theory, resource dependence, and transaction cost economics – deal with issues of the high level evolutionary processes, variation, selection, and retention.

that emerges in the market will exit, contributing to the shakeout. A formal model of industry life cycle evolution was then developed by Klepper (1997). His theory explains industry shakeouts in the evolution of new industries with a simple evolutionary model of entry and exit in four stages. In the first stage, when the industry emerges, several firms enter the industry because of market growth.

Table 5: Studies of Industry Life Cycles

Research	Issue	Explanations
Utterback and Abernathy, 1975 Abernathy and Utterback, 1978 Utterback and Suárez , 1993 Suarez and Utterback, 1995	Industry/market leadership	Emergence of a *dominant product design* as a key event that notably reduces the probabilities of success for subsequent entrants.
Clark, 1985 Tushman and Anderson, 1986 Anderson and Tushman, 1990 Anderson and Tushman, 2001	Emergence of dominant design as a basis of industry leadership.	Different *technological skills* of firms to explain firm survival. Technological breakthrough, or *discontinuity*, initiates an era of intense technical variation and selection, culminating in a single dominant design. Environmental uncertainty (e.g. change in demand or technological discontinuity) is the key environmental explanation on firm mortality. The greater the uncertainty the greater the exit raters.
Christensen, 1993 Christensen and Rosenbloom, 1995 Christensen et al., 1998	Firm survival and dominant design.	*Interaction* of technological, *cultural*, *managerial*, and competitive forces to explain firm survival.
Klepper, 1996, 1997, 2002, 2003 Klepper and Simons, 1997, 2002, 2000a, 2000b, 2005 Klepper and Thompson, 2005	Firm entry, exist and survival and industry *shakeouts*	Technology, firm size, age, prior experience, and location as key factors to explain firm survival after the shakeout. Early entrants and firms with prior experience are more capable to innovate and to invest in Research and Development (R&D.
Filson 2001	Firm survival	Technology and technological changes as a reason for firm survival.
Fein , 1998	Industry *shakeout* and firm survival	Early entry and innovation to explain firm survival.
Bergek et al. 2008	Shakeouts in mature industries	Technological capability to explain survival in shakeouts of mature industries
Agarwal and Gort, 1996	Firm entry, exist and	Entry and exit rates depend on the stage of

Agarwal and Bayus, 2004	survival	the industry life cycle. Survival rates depend both on the stage of the industry life cycle and on individual firm attributes.
Cattani, 2005, 2006	The impact of firm heterogeneity and technological innovation on technological performance	Technological *preadaptation* – as a part of a firm's prior experience that is accumulated without anticipation of subsequent uses – to explain future performance.
Bresnahan and Greenstein 1999 Breshnan, 2004 Chesbrough 2003 Mazzucato 2002	Causes of industry leadership and changes in the leadership	Vertical specialization, creative destruction, and entry into new submarkets as basis for changes in industry leadership.
Henderson and Clark 1990 Henderson 1999	Path dependence	Age dependence: joint effects of age and strategy produced long-term trade-offs across different performance outcomes.
Bonaccorsi and Giuri 2001	Evolution of vertically integrated industries.	The long-term evolution of an industry depends on the evolution of vertically-related, downstream industry.
Swaminathan 1998 Dowell and Swaminathan 2000, 2006 Dowell 2006	Entry into maturing industry	Though firms entering early may exhibit longer life spans, their advantages are limited to the period before the emergence of the dominant design. Overlap of production between and within product generations reduces firm mortality, as it allows firms to retain valuable routines. Excessive overlap, however, becomes harmful.
Geels 2002, 2005, 2006, 2007 Geels and Raven 2006 Verbong and Geels 2007	Technological transitions	Technological transitions, which occur as the outcome of linkages and interactions of developments at multiple levels to explain firm survival. The role of a socio-technical context and niches in technological transitions.

In the second phase, when the market continues to rise and there are increasingly more firms in the market, the competition intensifies and the profits reduce. In the third phase, the shake-out phase, the early entrants with research and development (R&D) expenditures, which can be spread over a larger output and therefore have lower unit costs, outperform the later entrants and smaller firms. This leads to the fourth stage, where entry becomes risky because large firms serve the entire market thus leading to a very concentrated industry. In sum, the shakeout is endogenous to the industry and it is caused by the internal dynamics of the industry. Klepper's (1997) theory has been tested and shown to be valid in empirical studies of several industries (Klepper and Simons, 2000a; 2000b; 2005; Klepper, 2002; 2003; Klepper and Thompson, 2005). Klepper and Simons (2000a) used the model to explain how the role of technological change shapes an industry's market structure. Their research of the US automobile tire industry showed that *technology*, in addition to firm *size*, *age* and *location* was a key factor explaining firm survival after the shakeout. The root causes behind the exploitation of a certain technology is seen to originate from the ability of a firm to innovate. More recently Klepper and Simons (2005) proposed that industry shakeouts are part of a competitive process in which early entrants are more capable to innovate and thus ultimately achieve a dominant market position.

However, the driving forces are different across industries. Klepper (2002) found differences between the evolution of the US automobile and tire, and the television and penicillin industries: prior experience conferred a much greater advantage in television and penicillin than in automobiles and tires. Klepper stated that this difference is particularly challenging to explain and leaves space for further studies of alternative theories of industry evolution to address these challenges. Moreover, in contrast to the technologically progressive manufacturing industries, Fein (1998) studied shakeouts in non-manufacturing industry (wholesale distribution of pharmaceuticals) and identified particular differences in the patterns of firms' exits and the role of early entry and innovation to firm survival. In addition, Klepper and Simons (2000a) identified that the success of Japanese TV producers attested to the potential effect that government policy and market institutions can have on the capabilities of firms. This factor, however, was not included in their formal modeling. In addition, technology is at least to some extent proprietary, and public policies have an impact on the level of publicity of technology (Nelson, 2005). In certain industries, especially regulated industries such as electric power industries (Joskow, 1997, 1988; Larsen and Bunn, 1999; Isser, 2003), airlines (Morrison and Winston 1995; Morrison 2002), train and postal services, and banking (Jayaratne and Strahan, 1997; Zúñiga-Vicente et al., 2004), insurance (Barron et al., 1998), and in telecommunications (Burton, 1997; Fransman 2001a, 2001b, 2003), the impact of institutions has proved to be significant on the structure of the industries and on individual firm survival.

In sum, the existing research on industry life cycles provides a viable model of the general industry life cycle in four phases including a sharp shakeout. It also provides evidence that a firm's *technology, age and size* have an impact on its survival, but leaves the effect of institutions in the background and unexplained.

3.1.2. Institutions

The evolution of industries is not only an endogenous process of aging. Nor can it be explained solely by the competition mechanisms in the market (Dimaggio and Powell, 1991)[10] or purely by innovation and technological advance. Indeed, in order to fully explain long-term change, a wide set of institutions have to be involved in the analysis (Nelson, 1995a, 1995b; Nelson, 2005). Or to put it in another way, as North (1990) has stated: institutions are "the underlying determinant of the long-run performance of economies" (1990:107)

The term 'institutions' has a wide set of meanings in social sciences. Traditionally, it has included items of 'culture' such as social norms, values, beliefs or standards (see Powell and DiMaggio, 1991). North (1990), representing a view of many 'new' economic institutionalists, defined institutions as 'rules of the game' in a society. Importantly, he distinguishes formal and informal institutions. According to North (1990), formal institutions are rules that human beings devise, such as laws. Informal institutions, on the other hand, are conventions and codes of behavior. Both certainly impact organizational evolution. Even if formal institutions are easier to recognize, informal institutions often form the microfoundations of formal institutions and thus influence firm traits. As Nelson (2006) argued, beliefs of the

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[10] According to institutional theories, organizations compete not just for resources and customers, but for political power and institutional legitimacy (DiMaggio and Powell, 1991). Thus this brings a new perspective to the pure 'market mechanisms' within an industry.

values and efficacy of a particular cultural trait strongly influence whether the trait is adopted, retained, or abandoned. Moreover, according to Nelson detail mechanisms of the informal institutions such as discussion, argument, persuasion, in some cases coercion, may be a central part of the selection process.

Overall, as Nelson (1995b) pointed out, the use of the term institution is very broad and might even be considered as vague in the scholarly literature. This also applies to the term institutionalization, which has several, albeit mostly complementary meanings (for a comprehensive summary see Aldrich, 1999, and a recent review in Nelson and Sampat, 2001). However, a common theme for institutional theorists is their interest in firm survival. This theme throughout the distinct branches of institutional theory is the influence of the environment over organizations. According to Meyer and Rowan (1977), organizational conformity with institutional myths provides them with legitimacy, which in turn has a positive impact on firm survival. In a similar vein, Dimaggio and Powell (1983) proposed that institutions make organizations more isomorphic and thus have an impact on the high-level evolutionary Variation-Selection-Retention (VSR) processes. They defined three mechanisms, coercive, normative and mimetic, through which institutional isomorphic change occurs. In addition, institutional theories have traditionally involved multiple levels of analysis and thus provide explanatory power of the interaction of organizations and institutions. In fact, institutions are an important part of a firm environment and the evolution of these institutions shape the industries as they evolve over time. Furthermore, organizations and industries shape institutions – either purposively or unintentionally- when the industries and institutions coevolve (Cohen and Noll, 1994; Nelson, 1995a; Lewin et al., 1999; Murmann, 2003; Bonardi, 2004; Bonardi et al., 2005).

The theoretical research and empirical studies on institutions in the scholarly literature is substantial. Within this extensive volume there are three areas of existing research on the evolution of institutions and the impact of institutions on industry evolution, which are particularly interesting from the viewpoint of this research: (1) formal institutions as form of public policies and regulation, (2) institutions dedicated to the generation and spread of technological knowledge such as universities and technical societies, and (3) the evolution of laws themselves. Each of these themes is addressed below.

First, *institutions in form of public policies* have an effect on industry evolution, industry structures and individual firm survival. These institutions include both those that are formal, such as government decisions, legislation and regulation, as well as informal institutions such as a social consensus in an industry, within clusters or groups or within a society or country. Ingram and Inman (1996) studied the co-evolution of institutions in both sides of the borders of Canada and the US in Niagara Falls. Their important finding was that the regulation provided by institutions lowered the failure rates and increased the founding rates of hotels on both sides of the falls. Holm (1995), studied the rise and fall of a specific institutional form, the mandated sales organization in Norwegian fisheries. He showed how changes in ideology and political actions created and abolished the system which had a monopoly control over defined segments of the fish trade between 1930 and 1995. Murmann (2003) investigated the synthetic dye industry in Europe between 1856 and 1914, and built a coevolutionary model explaining how Germany moved from a laggard to a leader in that industry. He found that the creation of German dominance cannot be understood without properly understanding patent laws, science funding and tariff lobbying in the different countries, and built a coevolutionary theory that explained how industrial leadership was gained and lost through the coevolution of firms, technology, and national institutions. In another recent example, Lamberg and Laurila (2005) showed that the country of origin had an effect on the organizational forms and further on the competitive conditions in the paper industry. In addition, Breznitz (2005) reported that the institution-based science and technology industrial policy of Taiwan has been helping the growth of the private IT industry when there has been non-competitive wide collaboration and coevolution between government-based research institutions and the private IT industry.

Second, *institutions dedicated to the generation and spread of technological knowledge* such as universities and technical societies are important components of the public part of the system supporting technical advance in industry and thus have a noteworthy impact the overall evolution of the industry (Nelson, 1986). Murmann (2003) for example, showed that the driving forces behind the dominance of the German synthetic dye industry at the beginning of the 19th century were due to strong academic-industry alliances.

A third interesting area is the *evolution of laws*. In some cases there is no real 'market' that sorts out proposed changes in laws. Rather there is "a set of economic and political interests, professional and lay beliefs about what the law should be, and a diverse set of mechanisms, some expressly political and some not, through which these interests and norms influence the evolution of the law" (Nelson, 1995b:83). For example, Ruostetsaari (1996, 1998, 2005) studied the evolution of the legislation relating to the electric power industry in Finland, and showed that industry associations and the firms in the industry had both a direct impact on the preparation of the legislation and on the content of the laws. Nelson (1995b) argued that we have very little understanding of how the selection environment of legislation works, and how it defines fitness. A recent research of evolution of laws by Jennings et al. (2005) is therefore particularly interesting because it does not only analyze the evolution of laws at a high level, but describes the mechanisms underpinning high-level processes. Their analysis of evolution of regional water law in British Columbia over a 90-year period showed that the number of law sections and the text covered by the sections actually declines over time, through alternating phases of gradual expansion, followed by rapid collapse. They identified two key processes *proliferation* of legal rules in the law via new births and revision of existing rules that generate new related rules, and *refinement* of existing law sections and of the law as a whole. Both processes acted between the different levels of analysis; the level of society, the legislation level, and the level of political and economic actors that impacted legal rule evolution. Their findings were different from the traditional Weberian rationalization view of legal rule evolution as they found out that legal rule changes and births were intensified by surrounding institutions and environmental shocks such as court cases, progressive political regimes and wars, while they were attenuated during political transitions and times of economic expansion.

To summarize, institutions have been proved to impact industry evolution. Furthermore the impact is clearly a two-way stream as represented in the research framework. However, the impact acts on several levels of analysis and includes distinct mechanisms. These mechanisms have a direct impact on the firms in the industry, but they also act through another important component of the research framework, namely technology.

3.1.3. Technology

The third element in the research framework is technology, a key driving force for long-term economical development (see Nelson and Winter, 1982; Nelson, 2005). The existing research provides evidence, that institutions and public policies in particular have an impact on the utilization of a technology in organizations through three key notable ways: (1) support for R&D (Noble, 1984; Rosenkopf and Tushman, 1994; Hafner and Lyon, 1996; Nelson, 2006), (2) educational institutes (Nelson, 1986; Murmann, 2003), and (3) enforcement of new laws and regulation (Ruostetsaari, 1989, 1998; Shan et al., 1991; Murmann, 2003). This impact is either direct or indirect. Patent laws are a good example of direct impact; they restrict the utilization of a certain technology, but only for certain organizations. Government support for R&D in educational institutes and the consequent impact on industries and firms represent an indirect impact. In both cases, the borders of the nation play an important role in the directing of the policy actions; the policies are typically used to protect certain innovations and technology of the country.

In addition to the impacts of institutions, the evolution of technology has its 'closed circuit' characteristics. The first studies of this area highlight the impact of technology in the form of dominant design (Utterback and Abernathy, 1975; Abernathy and Utterback, 1978). The key argument of the dominant design studies is that it is a certain set of events that lead to one technology or technical solution to become dominant, which ultimately leads the others disappearing from the market. In a long-term change process this dominant design is seen to rule the market until a new technology breaks through causing a continuum of cyclical evolutionary processes. The examples of the QWERTY typewriter keyboard (David, 1985) and certain railway track gauges (Puffert, 2002), show the *path dependence* nature of technology: the early stages of the evolution cause a *technological lock-in* and thus have an impact on later events and decisions. Ultimately this may lead to a situation in which one technological solution might win over another even if the solution might be less efficient than the abandoned alternative (Arthur, 1985, North, 1990). The root causes for success are seen as originating from a firm's ability to innovate (Klepper, 1997) or their internal routines (Nelson and Winter, 1982). North (1990) made an important point regarding the evolution of technologies: the competition is only indirectly between technologies; the direct competition is between organizations embodying the competing technologies. Similarly, Nelson and Winter (1982) highlighted the importance of a firm's internal routines in employing particular technologies. Thus the technology is a key characteristic of a firm and its *business model*, and therefore a part of the explanatory factors of a firm's survival over the long run. For this reason, the focus in this research is not on the evolution of technology itself, but technology as part of a firm's business model.

3.1.4. The firm

Firms and their characteristics act as key explanatory factors of the changes that can be identified at the level of the industry. The effect is two-directional: the firms coevolve with their environments (Lewin et al., 1999, Murmann, 2003). The other components of the research framework; the industry and the related competitive dynamics, the institutions in various forms – both formal and informal, and the technology all have an impact on the firm and act as an influence on its survival. The industry evolution scholarly tradition highlights the following key characteristics as sources of long-term change and explanatory factors of firm survival: (1) the firm's *age* and *size* in addition to (2) the *business model and internal capabilities* of a firm including the *technologies* it imposes.

With regard to firm age and size is argued and shown to have a positive impact on its survival. According to Klepper (1997), early entrants or older organizations have better opportunities for survival than later ones. Population ecologists (Hannan and Freemen, 1984) share the same view and argue that organizational death rate decreases with age. When it comes to size, the theoretical rationale is that this is associated with market power, which enables a firm to invest in innovation as a basis for further survival (Nelson and Winter, 1982; Klepper, 1996 Klepper and Simons, 2000; Klepper and Thompson, 2006; Hannan and Freeman, 1984; Hannan and Carroll, 1992).

Second, the *business model*[11] (Amit and Zott, 2001; Venkatraman and Henderson, 1998; Tikkanen et al., 2005) of a firm is a useful unifying concept and unit of analysis that captures the change arising from multiple sources. The business model of a firm includes the internal *routines*[12] (Nelson and Winter, 1982) of a firm as well as its *resources and capabilities*[13]. For example, innovation and related R&D in a firm are the key capabilities that explain the exploitation and evolution of technology within a firm (Schumpeter, 1934; Nelson and Winter, 1982; Klepper, 1996). A key characteristic of firm resources and capabilities is path dependence. It is not only the present environment and current resources and capabilities that have an effect on the firm's performance and survival (Helfat, 1994). Rather, the resources and capabilities of a firm have been built and accumulated (Dierickx and Cool, 1989) over a long period of time before the identified event (Helfat and Liebermann 2002; Cattani, 2005, 2006) also have an influence. The concept of a business model is comparable to the *organizational form* (Hannan and Freeman, 1984). Organizations having similar organizational forms are considered to be homogenous and it is not the individual firms but the organizational forms that will be selected (Hannan and Freeman, 1977, 1983, 1984; Hannan and Carrol, 1995).

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[11] In this study I use the concept of a *business model* to describe the differentiating capabilities of a firm as Tikkanen et al. (2005) have defined it: the business model of a firm include the firm's network of relationships, operations embodied in the firm's business processes and resource base, and the finance and accounting arrangements of the company.

[12] Nelson and Winter (1982) use a general term *routine* for all regular and predictable behavioral patterns of a firm. They include both technical capabilities as well as business strategies under the concept of a routine. The core in their theory is the regularity and predictability of these characteristics of a firm.

[13] The resource and capabilities are emphasized in the resource-based view (RBV) of a firm (Wernerfelt, 1984; Barney, 1986, 1991; Mahoney and Pandian, 1992; Amit and Schoemaker 1993; Peteraf; 1993).

Moreover, the surrounding institutions have an impact on the organizational form of a firm: they both enable and restrict the adaptation and development of organizational forms (Lewin et al., 1999). In addition, related to organizational forms, Hannan and Freeman (1977) highlight the role of *excess capacity* in times of changes to the environment. Generalist firms typically keep more excess capacity than specialists, and in stable times specialists will outperform generalists. However, in times of change to the environment the excess capacity allows flexibility for the firm and can be used for adaptation to the new situation (Hannan and Freeman, 1977). Thus, generalists have better opportunities for survival in times of major environmental changes compared to their specialist counterparts.

The business model of a firm defines the width of *vertical integration* of the firm. Generalists (Hannan and Freeman, 1977) typically cover several parts of the industry's value chain (Porter, 1985) or encompass operations from several industries. On the other hand specialists concentrate on a specific area of the value chain. In the early stages of an industry firms typically are vertically integrated generalists. As the industries evolve, vertical disintegration usually increases. The empirical examples of the automobile industry (Fine, 1998), computer industry (Baldwin and Clark, 2000; Jacobines, 2005), and biotechnology (Arora et al., 2000) show that there is a constant transformation towards vertical disintegration in several industries, which has redefined the roles of the existing firms and brought totally new firms to the industry. Recently, Jacobides (2005) demonstrated how business model evolution changed the industry in mortgage banking. According to Jacobides (2005) there were three stage processes which changed the industry structure and caused totally new markets to emerge. The first stage is constituted from the emergent motivating factors for disintegration; gains from specialization and trade. The motivators in turn put in motion two respective enabling processes[14]; intrafirm partitioning and interfirm co-specialization. As a result of these processes the market

[14] Although Jacobides (2005) uses slightly different concepts than has been used in this study, the principle is the same. The analogue of the concept of a 'process' in this study is the' mechanism'. The 'motivating factors' and 'necessary conditions' are representations of events during the evolution of the industry.

emerged in which two necessary conditions, coordination simplification and information standardization where met. They in turn led to the emergence of new markets. The process that Jacobedes (2005) identified was a typical emergent causal chain constituted from several events and mechanisms.

3.1.5. Surrounding society: Key events and environmental shocks

In addition to the four central elements of the research framework, the framework also includes three supplementary elements: (1) the surrounding society and related key events, (2) the competitors of a firm and their actions, and (3) the shareholders of a firm and its ownership structure. In this research, the competitive dynamics is considered to be part of the industry and the related market process. In addition, the shareholders and the ownership structure are considered to be part of the business model of a firm. Moreover, even if the society can be considered to form another level of analysis above that of the institutions, it is covered within the institutional level of analysis in the empirical study. The society also includes other industries and the nation - i.e. the context in which the industry is embedded. The existing literature shows that the long-term change in firms and industries is strongly interlinked with the national settings and country of origin (Sorge 1991; Djelic 1998; Lewin et al., 1999; Lamberg and Laurila, 2005).

In general life cycle models (Klepper, 1997) the shakeout is endogenous to the industry. However, in many cases there are episodes during the life cycle of an industry, when fundamental changes or challenges arise from outside of the industry. In addition to the impact of institutions, as the examples of the Oil Crisis in 1973 (Russo, 1992; Sine and David, 2003) show, there are key events or abrupt changes in society or other environmental jolts (Meyer, 1982) that may change the direction of the industry evolution. According to Nelson and Winter (1982), firms are much better in self-maintenance in a constant environment than they are at major change. Thus an environmental shock could be considered to have a direct impact on the industry. Indeed, it has been shown that uncertainty is a key environmental dimension associated with organizational mortality: the higher the uncertainty, the higher the exit rates (Anderson and Tushman (2001). According to Lewin et al.

(1991) this is due to the changes in the selection function of the organizations environment. However, despite the evidence of the impact of environmental shocks in industries, the question of how and why they have such an impact needs greater enlightenment. Or to put it in the form of the research motivation: "how can mechanisms be used to explain the impact of environmental shocks on firm survival and death?"

3.2. Research questions

Building on the key conclusions drawn from the review of mechanisms and causality as part of the evolutionary explanation, the following research questions are drawn from the theoretical framework and will guide the literature review of the current research on electric power industry:

1. How and why do institutions in a form of legislation, regulation, public policies and actions impact industry life cycle and industry structure?
2. What are the salient firm characteristics and thus key selection criteria that explain firm survival during the life course of a regulated industry and why?
3. What are the focal causal and evolutionary mechanisms that explain firm survival in a regulated industry? What are their key characteristics; how and why do they explain organization survival and death?

To answer these research questions, I conducted a literature review of the existing research of the selected regulated industry – the electric power industry. This review led to three regulated industry specific research propositions, which are examined in the empirical analysis of the electric power industry in Finland between 1889 and 2005.

4. ELECTRIC POWER INDUSTRY

The electric power industry, like many other regulated industries, has remained as a stepchild of the research of the open market industries in the management scholarly literature (Russo, 1992). A review of the literature reveals two exceptions. First, the process of deregulation raised the interest above the industry specific journals. Second, but only lately, the world-wide concern of the impact of climate change and energy generation on the environment and sustainability in general, has increased the interest on the electric power industry. For example, there was a whole session in the recent Academy of Management annual conference 2007 on the electric power industry with a title 'Shaping industry landscapes-how capabilities & politics determine the structure of the energy sector'.

There follows a review of the electric power industry research which is organized in three sections according to the research questions presented in the previous chapter. First, the studies of institutions in the form of legislation, regulation, public policies and actions as well as major external shocks and their impact on the industry are reviewed. Second, key characteristics of electric power industry firms and the distinct business models are presented. Third, the manifestation of path dependence in electric power industry is reviewed. At this point, specific research propositions are derived at the end of each section that will be scrutinized in the historical analysis of the electric power in industry in Finland between 1889 and 2005. The propositions are based on the key conclusions developed from the theoretical body of knowledge presented in the two previous chapters and enriched with the key findings of the existing scholarly literature of the electric power industry.

4.1. Institutions and electric power industry

4.1.1. Regulation and the electric power industry

Regulation has at all times been a central part of the electric power industry and has therefore impacted the evolution of the industry (Joskow, 1997). Moreover, the electric power industries have interacted actively with the central and local governments in the respective nations. For example, Hughes (1983) described in detail the wide range of legal and regulatory matters that needed to be decided before electric power could go forward strongly, and how the particular ways that they were decided affected the evolution of the technology. In addition, Granovetter and McGuire's (1988) analysis showed that in the US regulation promoted merger and rewarded urban capital-rich utilities, while disadvantaging publicly owned firms by locking in their geographical areas and prohibiting their operating rules. As these authors argued, the reason behind this was the personal impact of Samuel Insull,[15] and his network, on state regulation. Furthermore, in a recent study, Ibsen and Poulsen (2007) analyzed the establishment of the Danish regulatory authorities for the energy and telecommunications sectors. They found that a path-dependent sector-specific institutional process, in this case the negligible interest of the Danish government in the energy sector until the 1970s, formed the basis for strong energy companies that were capable of influencing regulation in their interest.

[15] Samuel Insull was the head of Chicago Edison and in practice led the development of the electric power industry in U.S. through his network. (see more in Granovetter and McGuire, 1988).

Hughes (1983) examined the history of the evolution of the electric power systems and industries in Germany, United Kingdom and United States during its formative years between 1880 and 1930. According to this seminal research, of the great construction projects of the 19th and 20th century, none has been more influential in its social effects than the electric power system. Moreover, he argued that power systems are cultural artifacts. According to Hughes (1983), the evolution of the electric power systems in western societies involves consideration of technical, scientific, economic, political, and organizational fields of human activity. Furthermore, in a more recent research Jacobsson and Bergek (2004) identified a 'cumulative causation' in the evolution of wind and solar power technologies in Germany. They argued that the processes of cumulative causation has to be created and supported by public policies in order to make the transformation process from incumbent technologies to renewable technologies self-sustained, or capable to be driven by its own momentum, rather than being dependent on repeated policy interventions.

In summary, the electric power industry, like the telecommunications, postal and airline services and the railways, were previously considered to be part of national infrastructure and consequently the firms in those industries were regarded as natural monopolies. Thus they were subject to government regulation; prices, entry, investment, service quality and other aspects of firm behavior were all regulated. Public policies, legislation and regulation have impacted the industry, but the industry has also impacted on public policies through a wide set of lobbying mechanisms (Myllyntaus, 1991; Ruostetsaari, 1998). Thus it can be said that the industry and the surrounding institutions in the form of public policies, legislation and regulation, have coevolved. Moreover, path dependence and ownership structures have resulted in the dominance of certain firms is a result both 'natural' evolution of the industry and the direct causal impact of institutions.

4.1.2. Deregulation of the electric power industry

In addition to traditional regulation, the customary regulation of firms in any field, the process of deregulation has been one of the key incidents in the history of the industry that has changed the 'rules of the game' in the industry. Starting in the 1980s the way of thinking in many national governments changed which led to a series of deregulation processes all over the world. For the purpose of this research there are three important areas in the scholarly literature on deregulation – and deregulation of the electric power industry in particular: (1) the general aspirations of deregulation, (2) key changes and issues in the electric power industry due to deregulation, and (3) the impact of deregulation on industry structure and firm survival.

With regard to the first of these themes, deregulation is a long-term process, from which the surrounding society posits to reap benefits (Winston, 1998). In theory an industry's adjustment to deregulation will cause intensified competition and increased operating freedom (Joskow, 1997). This will in turn cause the industry to become more technologically advanced, to adopt more efficient operating and marketing practices, and to respond more effectively to environmental shocks (Winston, 1998). However, deregulation itself also creates uncertainty or can even be considered as an environmental shock for some firms particularly firms with a specific business model (Sine and David, 2003). From the regulators' point of view there are five key goals of the electric power industry deregulation: efficient pricing of goods and service, efficient production costs, efficient levels of output and investment, efficient levels of service quality and product variety, and monopoly profit and rent extraction considerations (Joskow, 2007).

Concerning the second theme found in the literature - key changes and issues in the electric power industry due to deregulation- deregulation does not influence all segments[16] in the electric power industry in a similar way. In general, the retail and power generation segments are liberalized to foster market competitions in these

[16] The distinct segments of the electric power industry are described in detail in the next chapter.

segments. On the other hand, the transmission and distribution segments are still considered to be part of the national or local infrastructure and thus the goal of deregulation is to reform the regulation of these functions, which continue to be viewed as natural monopolies (Joskow, 1997). A central issue in deregulation has been to align the incentives of the firm with a business model that still remains to be regulated, such as electricity transmission or distribution, in order to operate efficiently while also assuring a reasonable level of profit for the firm (Kleindorfer et al., 2001). All in all, based on the experiences around the world there are some generic measures for achieving a well functioning market-oriented electric power industry. The national industry is considered to be deregulated if one of more of the following steps is implemented: sector restructuring, introduction of competition in wholesale generation and retail supply, incentive regulation of transmission and distribution networks, establishing an independent regulator, and privatization of the firms in the industry (Jamasb, 2002; Joskow, 1998; Newbery, 2002).

In the third theme in the literature, which concerns the impact of deregulation on industry structure and firm survival, deregulation has been seen to affect survival of individual organizations – positively for some, negatively for others. According to Winston (1998), substantial merger activity has generally occurred within a decade of an industry's deregulation. The net result of entries, exits, and mergers has been that competition in the market becomes more intense, although the total number of firms in an industry nationwide may either rise or fall. But what kind of firms will survive in the process? Delmas and Tokat (2005) found that large firms were the most efficient during the process of deregulation thus indicating that economies of scale play an important role in predicting efficiency. Moreover, several studies (Kaseman and Mayo, 1991; Lee, 1995; Kwoka, 2002) show the positive impact of vertical integration on firm profitability during regulation. This is elaborated in greater detail in the next chapter.

To summarize, deregulation has a clearly identifiable actor or an agent – in the form a regulator – with purposive goals to restructure the industry and thus impact the 'natural' evolution of the industry as well as directly cause changes in some firms within the industry. The policy measures initiate causal mechanisms, which together with the evolutionary mechanisms of the natural evolution affect the patterns of industry life cycle in the industry.

4.1.3. Impact of major external shocks

A third key element in addition to the natural industry life cycle (Klepper, 1997) and the impact of institutions, which may change the direction of the industry evolution for a while, is the impact of environmental shocks. Russo (1992) studied the impact of the sudden increase in regulatory actions due to the sudden and severe environmental shock, the Oil Crisis in 1973, on the electric power industry in US He found out that the Oil Crisis caused strengthened regulation, which in turn caused the costs associated with regulatory hearings, audits, and reviews to increase. These increased costs increased firm diversification and decreased vertical integration. The findings are fundamentally different from other forms of environmental uncertainty, where vertical integration is considered to reduce risks. Thus this combined causal chain from the environmental shock through the actions of the regulator caused a different outcome than would have otherwise been expected. In addition, Sine and David (2003) described, how the Oil Crisis started a series of events, which initiated a change in the electric power industry structure in US: "in the beginning of 1973, petroleum prices and interest rates skyrocketed, greatly increasing the cost of electricity generation. This resulted in an energy crisis that motivated Congress, the academic community, concerned citizens, and other stakeholders to search for alternative energy sources and organizational forms" (Sine and David, 2003:190).

In summary, taking into consideration the conclusions of the existing research on institutions, deregulation and external shocks (research question 1), and building on the theoretical body of knowledge of mechanisms in industry evolution, I offer the following proposition to be investigated in the empirical analysis:

Proposition 1: The general pattern of an industry life cycle is affected by institutions in a form of legislation, regulation and public policy measures, as well as by external shocks – induced by either agency identifiable or emergent causal mechanisms.

4.2. Business models of electric power industry

The existing literature shows that it has been common in the electric power industries to primarily evolve through vertically integrated geographic monopolies that were either state-owned or privately-owned and subject to price and entry regulation (McGowan, 1993; Borenstein and Bushnell, 1999; Joskow, 2003a). Gradually, value chain specialization generated different business models. Simultaneously, there has been a steady process of horizontal integration and consequently the number of power generation firms and distribution firms has reduced (Vickers et al., 1991, Yarrow, 1988). Three important elements of the distinct business models of electric power firms are presented in the forthcoming sections: (1) value chain specialization as a basis for a distinct business model, (2) vertical integration as an opposing process to diversification and, (3) the impact of international expansion and different ownership structures.

4.2.1. Electric power industry value chain

The value chain (Porter, 1985) of the electric power industry, depicted in Figure 7, is composed after the deregulation of five segments: power generation, trading, transmission, distribution and retail (Joskow, 2003a, 2003b). With regard to the first of these, the power generation segment, the electricity is produced in power plants from the raw material using different technologies like hydropower, thermal or nuclear power. Key determinants for success in power generation have been the utilization of economies of scale in production (Christensen and Greene, 1976; Christensen, 2001) and the exploitation of new technologies (Hughes, 1983; Joskow and Rose, 1985).The second segment of the value chain, the trading segment, enables firms to either trade electricity in a spot market directly with a counterpart on the over-the-counter market or on an exchange, was non-existing prior to the deregulation. The establishment of a wholesale spot market for electricity, which is a key component of electricity market deregulation (Joskow, 2003a), has typically been carried out as part of the deregulation. The wholesale price of electricity was principally regulated prior to deregulation. After deregulation, the large industrial customers were able to purchase electricity freely from any provider without regulation of the prices.

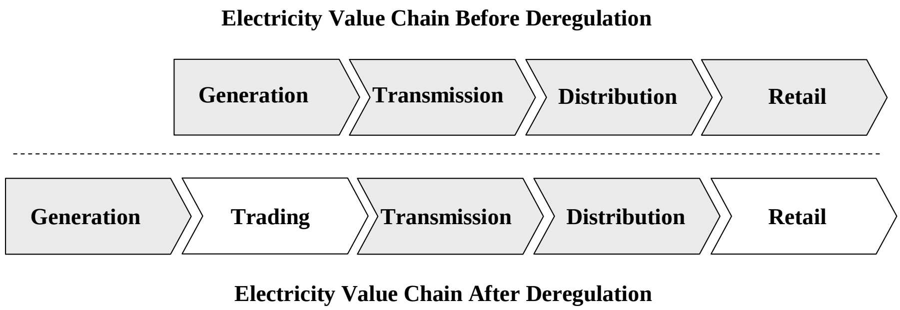


Figure 7: Electricity value chain before and after deregulation

The third part of the value chain concerns the electricity transmission segment's responsibility to construct and maintain the transmission network and of scheduling and dispatching generators to distribution loads according to least-cost principles. This last role of the transmission operator is known in the industry as the role of 'Grid Operator' or 'Independent System Operator' (Kleindorfer et al., 2001). The Fourth segment, the electricity distribution segment, consists of the building and maintaining of local electricity networks and the physical distribution of electricity in these networks. The retail of electricity to private consumers was, prior to deregulation, part of the distribution segment. Under deregulation it was detached from the distribution segment and opened up for competition. The distribution activity remained as a geographical monopoly under enhanced regulation (Kleindorfer et al., 2001; Joskow, 2003a). The distinct value chain components and the related segments have formed the basis for the different business models in the industry. A firm operates either on one segment or several segments. In the latter case the benefits of vertical integration between the segments is often the rationale behind the business model. Deregulation, as described earlier, impacted directly and purposively on the business models of the industry and consequently caused two new business models to be created: electricity trading and electricity retail. Simultaneously the rules of the game of the other business models were changed.

4.2.2. Vertical integration

In industries with highly commoditized products, the management of the supply chain is a crucial factor in successful firm operations (Cox, 2001). The profits in these networks are often unequally distributed, with some firms exerting power over the rest of the supply chain (Cox, 1999). Thus, it could be considered, particularly during a regulated episode, that vertical integration of electricity generation and supply (distribution and retail) would be beneficial. Studies by Kaseman and Mayo (1991), Lee, (1995) and Kwoka (2002) support this view and show that there has been a positive impact on firm profitability of the vertical integration of the different parts of the value chain in the electric power industry during regulation. What is more, it could be argued that increased market uncertainty during the process of deregulation would make vertical integration even more attractive. Thus firms with their own power generation would be less exposed to price volatility, because they could internally adjust supply and demand (Yatchew, 2000; Kleit and Terrel, 2001; Delmas and Tokat, 2005). This view may be supported by a transaction cost economics (TCE) argument (Williamson, 1971, 1985) that vertical integration reduces the transaction costs associated with uncertain market changes, which deregulation undoubtedly is. On the other hand, scholars such as Hill and Hoskinsson (1987) have argued that in a highly uncertain environment the costs of implementing vertical integration can be substantial. Moreover, Hunt and Shuttleworth (1996) stated that the assumptions relating to the existence of vertical integration could no longer be sustained after deregulation in the electric power industry- the period when the market opens for wholesale and retail competition.

Indeed, vertical integration raises the possibility that incumbents may favor their own divisions as sources of inputs for their own power generation, or their own electricity sales in the supply for their electricity distribution business due to the significant gains in transaction costs (Bergman et al., 1999). This process is a natural one in an open market system and thus there are mechanisms to drive the evolution of the industry towards vertical integration. In addition, vertical integration reduces the transaction costs associated with uncertain market changes such as deregulation, and therefore would be expected to be the direction towards which firms would evolve after deregulation. However, the legislation of deregulation induces coercive mechanisms against this trend to prevent undesirable windfall benefits from vertical integration to regulated operations such as power transmission or distribution. What is more, the electric power industry has been characterized by strategic centrality, high capital investment requirements and term planning horizons (McGowan, 1993). Thus, in addition to vertical integration or economies of scope, the benefits from economies of scale have been substantial, particularly in power production (Christensen and Greene, 1976; Christensen, 2001) and in electricity distribution (Yatchew, 2000). Accordingly, the larger the firm the better opportunities it has to survive.

4.2.3. International expansion and ownership structures

Initially, electric power industries were national. During the regulated episode regulation prohibited international entrants to enter the national market. As a principle, deregulation opened the market for international entrants. According to the international business literature, global strategies are likely to be efficient in sectors with large economies of scale and scope (e.g. vertical integration) and also in many deregulated industries (Victor, 1994). The traditional 'monopoly rent-maximizing' logic supports this view: the former monopolies try to maximize their monopoly rent at home, while expanding abroad to profit from opportunities created by deregulation. This phenomenon has also identified in the electric power industries in severel countries: the entrants to the liberalized or deregulated markets where the former national incumbents from other countries. According to Bonardi (2004) a notable aspect of their behavior was that it was 'asymmetric'. By asymmetric he means that firms take divergent stances on deregulation: they oppose them in their home markets, but wish to profit from them and push them forward in foreign markets. Bonardi (2004) took as an example EDF (Électricité de France) which tried to expand aggressively in international markets while lobbying for protectionism in France. In Europe, local and central government ownership was the characteristic form of electric power industry both before and after deregulation (McGowan, 1993, 2002; Borenstein and Bushnell, 1999). Thus the government acted in a double role; both as a public policy architect and as an owner of some firms in the industry – most often as an owner of the large incumbents. Bergman (2002) argued that this kind of ownership was used against foreign competition. According to Bergman, the national electricity markets in the Nordic countries (Denmark, Finland, Norway and Sweden), like in most European countries, used to be protected from foreign competition, tightly regulated and dominated by vertically integrated publicly-owned power firms.

As can be seen from the examples above, there were several parallel mechanisms related to international expansion that were active during the process of deregulation and that impacted the evolution of the industry. Some of the mechanisms were evolutionary, others causal. Moreover, institutions and public policies played an important role in the process. Based on the findings of the existing literature on the electric power industry, on the distinct business models and business model evolution, I offer the following proposition which will be investigated in the empirical analysis:

Proposition 2: The formation of a business model, a key evolutionary selection criterion, is an emergent result of a combined effect of both evolutionary and causal mechanisms.

The major idea behind the proposition lies in the 'both-and' and 'emergent' statements. Natural evolution and its related mechanisms push evolution towards business models that fit best to the environment. The purposive activity of regulation, on the other hand, strives towards business models which are desirable to achieve the goals of regulation or deregulation. The result is emergent; it cannot be fully controlled by the regulator due to the impact of the underlying evolutionary mechanisms. Thus, there is sometimes a need to 'correct' the combined outcome of evolutionary and causal mechanisms by new legislation and regulation. Examples of such outcome are the windfall profits (Verbruggen, 2008) for electric power firms. For example, Kara et al. (2008) reported that large windfall profits were expected to be incurred by electricity producers in the Nordic electricity market due to the EU emission trade regulation. The electric power firms would benefit from price increases, which would primarily have to be paid by the private customer and by the metals industries. The Finnish Minister of Trade and Industry commissioned a study, which included the identification of possible counter-measures against the foreseeable negative side-impacts of the price increases such as the reduced competitiveness of industry and increasing costs for all electricity consumer groups, the possible negative impacts on competition at the electricity market, and national energy supply security issues.

4.3. Path dependence in the electric power industry

4.3.1. Path dependence and firm survival

There are several examples in the scholarly literature of mechanisms that create path dependence in the electric power industry. For example, in his seminal study of the establishment and evolution of power networks in Germany, UK and in US, Hughes (1983) identified that coordination economies caused a lock-in advantage for the early established power networks that could not be overcome by the later competitors. Path dependence and related mechanisms can act either as benefits or (obstacles to the firms in the industry and thus either strengthen or dilute their survival.

With regard to benefits, in power generation, the time span for planning, constructing and operating a power generation plant is tens of years. The capital investment is often substantial compared to the yearly turnover of the firm, and the profitability of the investment is based on a long life span and relatively good input-output efficiency of the production plant (McGowan, 1993). In addition, in many countries different power production technologies need a license in order to obtain property rights from the regulative authority (Joskow, 1996). For example, as Myllyntaus (1991) showed, not all firms were able to build examples of nuclear power plants or obtain the water rights to build hydropower plants in Finland. The nature of a regulated industry and the related path dependence causes a ‘natural monopoly problem’ (Joskow, 2007), in which the general models of the barriers to entry - entry deterrence and oligopoly behavior - are linked together. In the natural monopoly problem the high level of investments and the related ‘sunk’ capacity costs (Kahn, 1970) create an asymmetry between firms which are already in the market and the potential entrants. This asymmetry can act as a barrier to entry by giving first mover advantage to the firm that is the first to enter the market (Sutton, 1991, Joskow, 2007). After deregulation this first mover, the former incumbent and often government-owned monopoly, has significant benefit over the other competitors.

In terms of path dependence and related mechanisms acting as an obstacle, in his research Hirsh (1989) provided an explanation of technological stagnation and its contribution to industrial decline. He analyzed technological development, the culture and leadership of the organizations and the impact of the surrounding stakeholders such as customer, investors and regulators on the evolution of the US electric power industry in the 20th century. After improving steadily for decades, the productivity gains from the existing technology developed beliefs held by the industry managers of future improvements and growth, but in fact caused the industry to stall. Facing the boundaries of efficiency gains of the late 1960s and 1970s, the firms could not mitigate the economic and regulatory assaults of the 1970s and as a result in the 1980s the industry found itself in the middle of deregulation and restructuring. Hirsh’s (1989) research is interesting because the technological stagnation, and the resulted industry decline and restructuring, that he identified is different from the predominant views on dominant designs, which lead to a mature industry until a new dominant design breaks through. Hirsh (1989) provides a ‘sociotechnical’ explanation for this. Triggered by the Oil Crisis in 1973, but evolved over a period of decades, the firms in the industry could not respond to the shock to their business environment. Consumers and regulators irritated by the first-ever experiences of increases in electricity prices, a new ‘environmental consciousness’ led to recrimination against the industry, and investors, who lost their trust to the traditional safety of the electric power industry sought better opportunities and returns for their investments. However, the industry decline remained a US phenomenon. Hirsh (1989) identified two key reasons for this. First, the US constituted the world’s largest market for electricity and thus needed and had the greatest capacity. If practical limits in technological advance were to be encountered they would show up first in the US Second, the country had a decentralized electric power industry with hundreds of firms (compared to other large countries such as UK or Germany (see Hughes, 1987)), largely financed through free-market mechanisms and governed only loosely by the regulatory bodies.

4.3.2. Path dependence and technology lock-in

The substantial levels of investments required for power generation, and the lock-in to the selected technology due to asset mass inefficiencies, may change the fitness of a firm and consequently impact its survival when key factors in the environment, which define the fit, suddenly change. These changes in environmental factors impact the overall viability of certain technologies, and amplify the impact of the path dependent mechanisms both directly and through regulative institutions. The following examples provide enlightenment on this process.

The first example is that of the Oil Crisis in 1973 which caused the oil price to escalate, which in turn deteriorated the profitability of thermal power plants using oil as a raw material. A second example is that of Cowan's (1990), empirical study of the electric power industry which showed the impact of public measures on technological evolution. He showed that the adoption and heavy development of the light water nuclear power reactor technology by the US Navy in addition to the US government subsidies caused a technological lock-in to that specific technology not only in US but also in Europe. A third example concerns institutions such as the environmental movement that caused a 'nuclear power trauma' in Sweden (Jacobsson and Berkek, 2004) and in Germany, and ultimately caused political decisions in Germany and Sweden to stepwise abandon nuclear power. The fourth example concerns the ongoing discussion of climate change. The notion that climate change has been caused by CO_2 emissions has led to coal based thermal power plants becoming not only unfavorable, but due to emission trading regulation in the European Union also unprofitable. This has therefore further impacted the electric power industries profitability and survival. At the same time other technologies, such as wind or solar energy have become more viable. However, as Christensen (2002) indicated, public policies and measures are needed to support these new technologies. Christensen studied the linkages between public policies and new renewable energy sources and technologies within the context of energy and climate change policies in Norway. The primary conclusion of his research was that in spite of long-lasting public efforts, new renewable energy sources represented only a very small fraction of the energy produced in Norway. This was due to path dependence which created a strong position for the prevailing technologies, leading to low electricity prices, and to fluctuating patterns in public priorities. For this reason Christensen (2002) suggested that in order to promote new technologies and innovation, public policies should be based on long-term commitments to guard against path dependence.

Finally, taking into consideration the theoretical body of knowledge in industry evolution research enriched with the theories of causality and drawing on the existing literature of the electric power industry (research question 3) I offer the following proposition which will be investigated in the empirical analysis:

Proposition 3: The cumulative causal mechanisms during the evolution of a industry cause path dependence in the form of asset constraints and a business model lock-in that have an impact on industry structure and firm survival.

5. METHODOLOGY

5.1. Research site

The electric power industry is an interesting empirical environment to study the interplay of institutions, technology and the market and their impact on the industry structure and on individual firms. First, in most countries electric power industries have evolved from an industry with private or government owned monopolies, subject to price and entry regulation and extensive asset regulation, such as electricity network and power plant licensing (Hughes, 1983; Joskow, 1997) into a semi-deregulated industry with partial market-based competition and subject to the great impact of government policies (Ruostetsaari, 1989, 1998). Thus, the fundamental 'rules of the game' of the industry has been determined by regulation. Second, the evolution of power generation technologies has played a great role in the evolution of the industry all over the world (Hirsh, 1989, Joskow and Rose, 1985; Myllyntaus, 1991, Hargadon and Douglas, 2001). Third, the characteristics of the firms in the industry have evolved with specialization to certain parts of the value chain (see Kaseman and Mayo, 1991; Lee, 1995; Kwoka, 2002; Christensen and Greene, 1976; Christensen, 2001) leading to distinct business models.

This research is based on a longitudinal analysis of the Finnish electric power industry between 1889 and 2005. The research covers the whole lifetime of the industry from the birth of the firms until the recent years. The electric power industry in Finland was highly regulated until the mid 1990s. After that it was among the first electric power industries in the world to undergo a major deregulation process. The Finnish society has evolved during this time period from a highly agricultural society to one of the leading industrialized societies in the world. Moreover, this period contains major transformations and environmental shocks of the Finnish society such as the process of industrialization, the Second World War, the Oil Crisis, two major recession periods and the accession of Finland to the European Union. During this period, the government policies, institutional organizations, and key firms of the electric power industry and other major industrial firms have impacted significantly on the evolution of the electric power industry as Myllyntaus (1991) and Ruostetsaari (1989; 1998) have documented in their studies. The Finnish case is also interesting, since the electricity market reform in the country is unique compared to many other countries in the sense that even before the official market deregulation in 1995, the market was already very open compared to most of the other European countries, as Pineau and Hämäläinen (2000) have pointed out. The changes were made gradually, not radically, like in UK, in which on main utility firm was broken down and privatized in one go (Newbury, 1997; 2002).

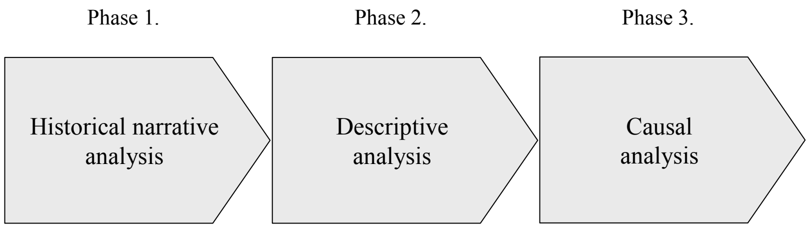
5.2. Research design

There are different ontological views among organizational scholars whether organizations consist of things or processes (Rescher, 1996; Tsoukas and Chia, 2002). Consequently, these two views lead to different epistemologies about variance or process methods for conducting research (Mohr, 1982; Van de Ven and Poole, 2005). Furthermore, the different ontological views and epistemologies lead to two distinct definitions of change. Long term changes is either seen as an observed difference over time in an organizational entity on selected dimensions with a focus is on variable changing over time (Nelson, 1995b), or a narrative describing a sequence of events on how development and change unfold (Poole et al.

2000). The tradition in industry evolution research includes a rich set of methodological solutions ranging from pure variance methods with theorizing leading to mathematical models (Nelson and Winter, 1982; Hannan and Carrol, 1992) to historical narratives (Hughes, 1983; Hirsh, 1989; Myllyntaus, 1991). Traditionally, the goal of historical analysis is to develop accurate descriptions of social phenomena on the basis of careful consideration of all relevant and available data (Golder, 2000). In this method one should strive to understand events in their full context, seek generalizations and admit exceptions, try to understand the causes of events and to assess their relative importance, and look beyond immediate causes in order to also determine underlying explanations (Smith and Lux, 1993; Golder, 2000). Nevertheless, narratives also need systematic data to discover the phenomena behind the change (Murmann, 2003). However, theory building needs rich description, and the richness comes from the anecdotal data. Consequently, the phenomena are uncovered using the 'hard' data, but the 'soft' data is used to explain many of the causal relationships (Mintzberg, 1979). Thus, combining the pluralistic insights from the different approaches – variance and process methods – provides a richer understanding of organization change than any one approach provides by itself (Van de Ven and Poole, 2005).

In this research, I am following a tradition, which has recently become increasingly employed (see Murmann, 2003; Geels, 2002, 2005, 2006, 2007; Geels and Raven, 2006; Lamberg and Laurila, 2005; Lamberg and Tikkanen, 2006, Lamberg et al., 2008). These studies combine systematic descriptive analysis with historical narrative analysis. Indeed, in order to be able to draw conclusions on causal inferences, the combination of historical narratives and descriptive or quantitative analysis is needed. Causal analysis is a synthesis of these two. Accordingly, the research process of this research consists of three phases as depicted in Figure 8. Moreover, I utilized several research strategies (Langley, 1999) during the phases. A summary of the research strategies in presented in Table 6.

First, I started with a detailed *historical narrative analysis* of the life cycle of the Finnish electric power industry covering the entire lifetime of the industry: a period that extends over more than a century. Following the research framework, I divided the analysis into subsequent sections: the overall industry history, the evolution of institutions in the form of public policies, the evolution of electricity consumption and power generation technologies, and the evolution of distinct business models.



	Phase 1. Historical narrative analysis	Phase 2. Descriptive analysis	Phase 3. Causal analysis
Content	• Industry history • Evolution of institutions in the form of public policies • Electricity consumption and power generation technology evolution • Evolution of business models	• Descriptive numeric analysis of firm entries and exists from the industry by business model	• Key events during the selected episodes • Identification of causal connections and active mechanisms between the events
Goals	• Identify patterns of industry life cycle • Identify key events and causal linkages during the industry life cycle	• Provide evidence of distinct types of firm mortality and survival during selected episodes	• Explain the causal connections between the events and identify the key mechanisms by combining the historical narratives and descriptive numeric evidences

Figure 8: Research process

From the above and as illustrated in the research framework, I started from the highest level of analysis – the entire lifecycle of an industry and then drilled down to the distinct components which have, according to the existing literature, an impact on the overall industry structure and individual firm survival. In Phase 1 of the research process I utilized *narrative strategy*. At the heart of narrative strategy lies a *historical narrative* (Abrams, 1982; Sayer, 1992; Griffin, 1993; Mahoney, 1999). However, the goal of the narrative strategy not to tell a story with sequences of events; it aims to present analytical chronologies in order to "get on top of the data, to clarify sequences across levels of analysis, suggest causal linkages between levels, and establish early analytical themes" (Pettigrew, 1990:280). Thus the goal of the Phase 1 historical narrative analysis was to identify the patterns of industry life cycle, the key events and causal linkages during the industry life cycle. Accordingly, the historical narrative can be considered as an analytical construct of sequential accounts that organize events and actions into chronological order (Sayer, 1992; Pajunen, 2004), which in turn form the basis for the causal analysis carried out in Phase 3.

Table 6: Research strategies

Research Strategy	Key Anchor Points	Level of Simplicity	Method
Narrative strategy	Time	Low	Construction of a detailed qualitative analysis from the raw data
Temporal bracketing strategy	Phases, Episodes	Low	Decomposing the data in periods, where there is certain continuity in the activities within each period and certain discontinuities at its frontiers.
Visual mapping strategy	Events, orderings, causality	Moderate	Visual graphical presentation of event history chronology and the causal connections between the events; *causal diagrams*
Descriptive analysis	Firm entries and exits	High	Descriptive analysis of selected measures

In Phase 2 I performed a *descriptive analysis* of firm entries and exits from the industry in order to understand and explain the overall pattern of the industry's life cycle and more particularly to identify possible industry shakeouts. I then continued the descriptive analysis of firm exits and entries according to the firm business model to provide evidence of distinct types of firm mortality and survival during the shakeout episodes.

The descriptive analysis together with the narrative analysis performed in Phase 1 built the basis for identifying the *explanandum* or, the stage of the evolution that described the result of the phenomenon (Mayntz, 2004).

Building on the two first phases of analysis, I utilized *temporal bracketing strategy* to deconstruct the data – in my case the life cycle of the electric power industry in

Finland – into “successive adjacent periods enabling examination of how actions of one period lead to changes in the context that will affect action in subsequent periods” (Langley, 1999:703). Accordingly, I split the analysis into stages or cycles (Van de Ven and Poole, 2005) of change and specified the two key episodes (Tilly, 2001) which had the most fundamental impact on the structure of the industry.

In Phase 3 I performed *causal analysis* of the key events during the two selected shakeout episodes in order to explain the causal connections between the events. This methodology is similar to the 'counterfactual history' methodology presented by Durand and Vaara (2009)[17]. As Mayntz (2004) states, "explanation means causal reconstruction, a retrospective process-tracing that ends with the identification of crucial initial conditions” (2004:244). Accordingly, I first identified the *explanans* – the initial causes of the *explanandum* by combining the findings of the historical narrative analysis and descriptive numeric evidence.

In this phase I used a method similar to the 'process tracing' (Steel 2004[18]; George and Bennett, 2005). For the process tracing I employed a *visual mapping strategy* (Miles and Huberman, 1994, Langley and Truax 1994; Mintzberg et al., 1976) in order to discover how the events were linked together: I used causal diagrams (Pearl, 2000) to visualize the causal connections between the key events.

After visualizing I proceeded to identify the generative mechanisms. The challenge of identifying mechanisms is that they are typically unobservable and therefore their description is bound to contain concepts that do not occur in empirical data (Bunge,

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17 Durand and Vaara (2009) offered a 'counterfactual history' methodology, which consists of three steps: (1) identifying of critical events through a careful mapping of events and a thorough analysis of how these events relate to the more general facts, (2) causal process and mechanism specification based on the events models and existing body of of knowledge, and (3) the use of counterfactuals to establish causations.

18 Process tracing (Steel, 2004) "consists in presenting evidence for the existence of several prevailing social practices that, when linked together, produce a chain of causation from one variable to another. A successful instance in process tracing, then, demonstrates the existence of a social mechanism connecting the variables of interest".

2004). Thus, in order to identify the mechanism, I proceeded to describe the behavior of the mechanism and its key characteristics. At this stage I used additional empirical evidence from archive data of the relevant legislation and institutional committee reports and memorandums.

Forms of graphical analysis and presentations are a useful extension to the prevailing methods of evolutionary research. They are particularly functional for the kind of research framework that I employ in this research. They allow simultaneous representation of large number of dimensions together with parallel processes and mechanisms (Langley, 1999) and also permit description of causality between events and thus reveal the impact of causal mechanisms in addition to those that are evolutionary.

5.3. Data sources

I collected archival and statistical data and studied several existing studies of the electric power industry in Finland to conduct the research in three phases as described in the previous section. In order to conduct the in-depth historical analysis and to identify the key events during the lifecycle of the industry I relied on four types of historical accounts and archival sources.

I examined annual reports of the key firms in the industry (Imatran Voima, Fortum, Vattenfall, E.ON Finland, Länsivoima, Helsingin Energia, Pohjolan Voima) and firm and industry association histories (Imatran Voima, Länsi-Suomen Sähkö, Jyllinkosken Sähkö, Vaasan Sähkö, Savon Voima, Finnish Electricity Utilities (Suomen sähkölaitokset) 1984, 1989, The Finnish Electricity Association). In addition, I collected public documents from market organizations and regulators such as the Finnish Electricity Association SENER, Finnish Energy Industries and the Energy Market Authority of Finland. I studied thoroughly the relevant legislation and their debate in parliament committees, as well as the industry committee reports and memorandums as referred in the analysis.

I also examined the electricity related publications of the Ministry of Trade and

Industry and the meeting minutes of the most important government appointed committees during the period of analysis. Finally, I examined several earlier studies of the electric power industry in Finland as referred to in the analysis. These two earlier studies of the Finnish electric power industry carried out by Ruostetsaari (1986, 1998) provided particularly useful detailed support information and evidence for the inference of causal and evolutionary effects between specific events. In order to carry out the descriptive numerical analysis, I collected a comprehensive data set of Finnish energy statistics for the years 1930-2005 as described in Table 7. The Electricity Law of 1928 stipulated that statistics should be collated from the industry and these were compiled from 1930 onwards in five year intervals, and from 1974 onwards as annual records.

Table 7: Archival statistics data

Publisher	Source of Statistics
The Electrical Inspectorate of Finland (Sähkötarkastuslaitos)	Electricity Statistics for Finland (Sähkölaitostilasto) 1930, 1935, 1940, 1946, 1950, 1955, 1960, 1965
Imatran Voima Oy	Electricity Statistics for Finland (Sähkölaitostilasto) 1951-1955, 1956-1960, 1961-1969
The Finnish Electricity Association (Suomen sähkölaitosyhdistys)	Electricity Statistics for Finland (Sähkötilasto) 1970, 1974
Electrical Inspectorate of Finland (Sähkötarkastuskeskus)	Electricity statistics for Finland 1975-1997
Adato Energia Oy	Electricity and district heating 1998-2004 Excel worksheets of electricity statistics from the years 1990, 1995, 2000, 2005
Finnish Energy Industries (www.energia.fi)	Energy Statistics, 1990-2005
Energy Market Authority	Excel worksheets of electricity statistics of electricity sales and distribution firms 1996-2005 Database of electricity prices 1992-2004
Statistics Finland	Excel worksheets of electricity statistics 1970-2005

For the years in which there were no statistical data available, I linearly interpolated the observation values as an average between the two closest available years[19]. The oldest data if from statistics publications, but for the periods since 1990 I also obtained Excel worksheets from Adato Energia Oy and from the Energy Market Authority.

Table 8: Variable and events in the three levels of empirical analysis of the research

Level of Analysis	Variables in the descriptive analysis	Events in the causal analysis
Institutional level	No descriptive analysis performed	• Laws and regulations • Key government actions • Key environmental shocks in the society (wars, EU membership etc.)
Industry level	• Portfolio of business models (number of firms, entries, exits; production; consumption) by year • Number of end users by group • Electricity consumption per group • Power generation per technology • Business model profitability (partly before deregulation, fully after deregulation)	• Laws and regulations • Changes in the portfolio of business models (e.g. new business models) • Technological events • Key change events (e.g. international entrants) • Institutional events (industry associations and other supporting institutions) • Market changes • Firm number changes
Firm level	• Firm entry and exit dates to the industry • Business model • Production technology • Vertical integration (e.g. own power generation or not) • Power generation capacity • Number of end customers • Total electricity sales and the share of own production • Ownership structure • Country of origin	• Firm entry and exits • Mergers and acquisitions • Technology selections • Key firm level events (e.g. changes in profitability)

[19] The number of firms has been interpolated for 1932, 1934, 1936, 1938, 1939, 1941-1945, 1947-1949, 1951-1954, 1956-1959, 1961-1969, 1972, and 1973. Consumption has been interpolated for the years 1932-1934, 1936-1938, 1941-1944, 1956-1959, 1961-1964, and 1971-1973.

I used the energy statistics to compile a database, which contains both industry and firm-level data. I compiled from the archival data sources a database with data on three levels of analysis; institutional level, industry level and firm level.

The summary of the three levels of analysis and the variables used in the descriptive analysis as well as the events used in the causal analysis is described in Table 8. First, in the institutional level I collected the key laws and regulations and other public policy actions as well as key environmental shocks in the society. Second, the industry level includes variables such as the portfolio of business models during each episode, the yearly total number of firms and the variation of the number of firms in the industry by business model, number of end users and total consumption of electricity, power generation per technology. At the level of the industry, the analysis based on the variables gave me an overview of the life cycle of the industry. In particular, it helped to identify the two major shakeout episodes in the industry. I also collected the key events, such as technological and market changes, of the industry level. Third, at the firm level, I collected information in five year intervals. The database includes information on the volumes of electricity production and supply, production technologies, number of customers, business models and ownership structures. Furthermore, the data from the deregulated episode during 1996-2005, collected from the annual statistics of the Energy Market Authority, includes detailed firm-level financial information such as firm turnover and profits. This firm-level data enabled me to analyze the differences between different types of firms and provided a basis to investigate which kinds of firms survived the shakeouts.

6. ANALYSIS OF DATA

I have divided the analysis of data in to six sections. The analysis starts from the highest level of hierarchy of the temporal dimension of analysis – the entire lifetime of the industry. I then drill down into the hierarchy to key episodes and finally to the mechanisms that made the changes happen at the different levels of analysis. In the analysis I follow the structure of the research framework of the research and employ a variety of relevant research strategies throughout the analysis.

In the first section, utilizing the historical narrative strategy, I describe the evolution of the Finnish electric power industry between 1889 and 2005. I highlight the key events in the different levels of analysis. Based on the descriptive analysis and the supporting descriptive measures of firm entries and exits I divided, according to the temporal bracketing strategy, the lifetime of the industry into four periods, reflecting certain continuity in the activities within each period and certain discontinuities at its frontiers (Langley, 1999). I then explored these periods as a grouping of the historical analysis. In the second section, in accord with the research framework, the evolution of the formal institutions – public policies – and their impact on the overall industry evolution is analyzed. Thereafter, I elaborate the evolution of two key characteristics in the environmental settings of the industry and the firms: market growth (and decline) in terms of changing customer needs and increase of demand and consumption, and the evolution of the core technology in power generation. The fourth section concentrates on the evolution of the industry structure in the form of the emergence of distinct business models through diversification of the value chain. In addition, the dominant firms in the industry and their business models, and the association between the business model and market dominance is analyzed in this section. In the fifth section I scrutinize the two shakeout episodes of the industry in order to be finalized for a causal evolutionary analysis. This is carried out by combining the descriptive analyses of firm exits during the shakeouts with a visual mapping of the key events identified in the previous analyses and their causal connections in the form of causal diagrams.

6.1. The history of the industry: Four periods of evolution

A summary of the four phases of evolution of the Finnish electric power industry between 1889 and 2005 is presented in Table 9. The distinct periods are also depicted in Figure 9; a chart that describes the evolution of the total number of firms in the industry and the development of electricity consumption in the country during the period of evaluation. I label the first period ‘Utility Start-up’. It commences with the birth of the industry and continues as an initial growth period. The key incident between period one and two was the Second World War. The second period, which I label 'Institutionalization', continued as a notable growth period taking into consideration the number of firms in the industry. However, the number of firms started to decrease from 1971 onwards, which initiated the third period. Simultaneously, the electricity consumption increased significantly during this period and therefore I label it 'Increasing Demand'. Finally, the new Electricity Market Act in 1995 turned the evolution of the industry to period number four, 'Deregulation'.

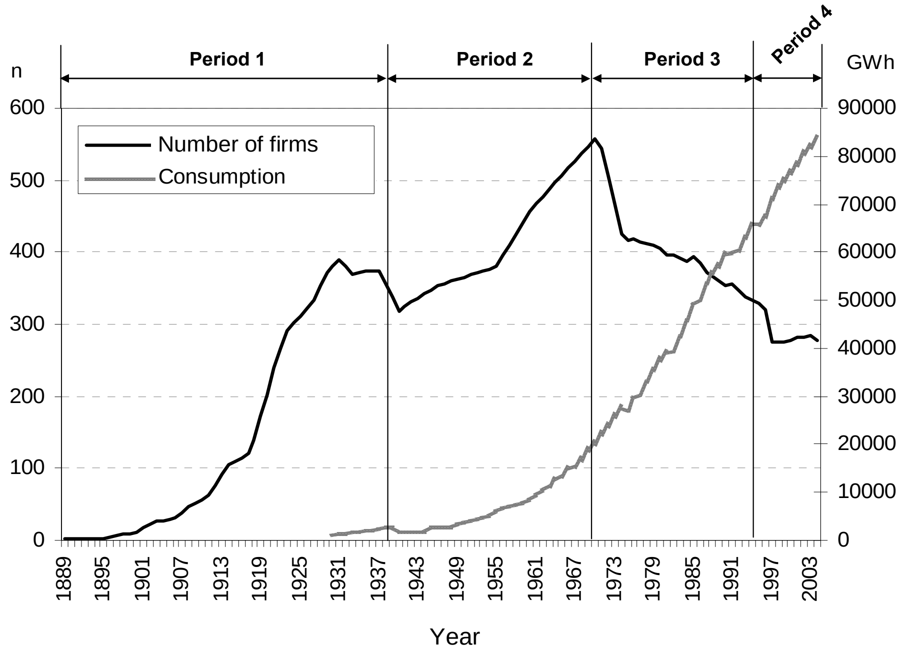


Figure 9: Total number of firms and electricity Consumption in Finland 1889-2005. Left axis: number of firms, right axis, electricity consumption, GWh. Source: Finnish electricity statistics 1930-2005.

6.1.1. Period 1: Utility start-up 1889-1938

In 1877, electric lighting using a steam-driven dynamo was experimented with for the first time in Finland. The history of the utilization of electric power in Finland started from these experiments, and from the subsequent public demonstrations of electric lighting in Helsinki. The electricity industry is seen to have started in Finland on the 15th of March, 1882, when the first notable electricity lightning system was taken into use at the Finnlayson textile factory in city of Tampere (Kunnas, 1985).

Table 9: Summary of the four phases in the evolution of the Finnish electric power industry 1889-2005

Period	**1. Utility Start-up**	**2. Institutionalization**	**3. Increasing Demand**	**4. Deregulation**
Time period	1889-1938	1939-1970	1971-1994	1995-2005
Society	▪ Regulated environment ▪ Rural population ▪ Industrialization starting	▪ Regulated environment ▪ Rural population ▪ Industrialization starting ▪ Bilateral trading with the Soviet Union ▪ High government ownership in forest and energy industries	▪ Deregulation starting in some industries ▪ Urbanization increasing ▪ Forest industry growth and consolidation starting ▪ Oil Crisis 1973	▪ Deregulation and market opening in many industries ▪ Urban and economically wealthy population ▪ Growing investments to energy heavy industries (forest, metal)
Electricity consumption	▪ Very low	▪ Starting to grow	▪ Major growth	▪ Increased demand
Key new technological innovations	▪ Hydro ▪ Thermal	▪ Thermal (Oil, Coal)	▪ Nuclear power ▪ Natural Gas	▪ Wind
Industry evolution	▪ Number of entries high, very few exits	▪ Number of firm entry increasing, but slightly more moderately than in the previous phase	▪ Consolidation starting, number of exits increasing	▪ Consolidation continuing, but still moderate ▪ International firms entering markets
Electricity firm characteris-tics	▪ Public electricity infrastructure development ▪ Multiple, isolated electricity firm entities ▪ Vertically integrated firms	▪ Fulfillment of the public sector duties and industry needs ▪ Multiple, isolated electricity firm entities ▪ Mostly vertical integrated firms	▪ Economies of scale driving specialization (vertical disintegration) ▪ First nuclear power plants starting	▪ Specialization (vertical disintegration) continues ▪ Electricity sales firms starting after deregulation
Key Legislation	▪ Electricity Laws 1901, 1928 ▪ Water Acts	▪ Two countryside electrification committees after World War II	▪ Electricity Law 1979	▪ Electricity Market Act 1995
Market dominance	▪ Local, municipality owned electricity firms, state owned IVO and industries own electricity firms	▪ Local, municipality owned electricity firms, state owned IVO and industry-specific electricity firms	▪ Production: Fortum, Pohjolan Voima, Teollisuuden Voima, Helsingin Energia ▪ Distribution and Sales: Helsinki, Tampere, Turku	▪ Production: Fortum, Pohjolan Voima, Teollisuuden Voima, Helsingin Energia ▪ Distribution and Sales: Fortum, Vattenfall, Helsingin Energia, E.ON
Key dates and firm entries	▪ 1907 Helsingin kaupungin sähkölaitos (Helsingin Energia) founded ▪ 1922, Imatran Voima Oy (IVO) founded	▪ 1943, Pohjolan Voima founded ▪ 1969, Teollisuuden voima founded	▪ Loviisa nuclear power plant starting (1977,1981) ▪ Olkiluoto nuclear power plant starting (1978,1980) ▪ 1994, Vattenfall Oy founded	▪ 1997, Finnish Power Grid Oy (Fingrid Oy) founded ▪ 1998, Nord Pool, starts operation in Finland ▪ 2001, E.ON acquired Espoon Sähkö

Gradually, as Myllyntaus (1991) described in his detailed research 'Electrifying Finland',[20]the use of electricity for different purposes spread all over the country. Experiments with the commercial use of electricity for different purposes continued during the rest of the 1800s. Even if industrialization started gradually in Finnish society during this period, the era was characterized by the importance and relatively high ratio of agriculture to the gross national product of the country[21]. The demand for electricity in agriculture was very low and the role of agriculture in political decision making was important. Thus it was logical that it was the municipalities that took a major role in establishing and building the electric utilities. On the other hand, looking at the share of the industries total production in Finland, the rise of forest industry had already started during this period (Hjerppe, 1989).

Electric power as a public utility industry started in Finland in City of Tampere on November 15th, 1888. The first power firms, some of them private enterprises and some public utilities[22], were established from the 1880s onwards for different purposes. The primary uses of electricity were for lightning both in cities and in factories (see Figure 10). However, the use of electricity for manufacturing, using electric motors as source of power, also started to increase gradually, although it was not yet significant during this period (Jaakkola, 1982; Myllyntaus, 1991). According to the Finnish electricity statistics, the first registered electricity firms were founded in 1889, which is also the starting point of the observation period for this research. In addition to the Electricity Utility for the City of Tampere, the first electricity firms mentioned in the statistics were the Electricity Utility for the City of Rauma

[20] Myllyntaus' (1991) aim was to investigate the adoption process of new technology in a latecomer technology. Although his main focus is on technology adoption his research can be considered as the first detailed analysis of the history of electricity in Finland. It also includes detailed information about the utilities and legislation between 1877 and 1977, which has been very valuable for the present research.

[21] According to Hjerppe (1989), the percentage of agriculture of Finland's GNP was 38 percent in 1889, 30 percent in 1909, 38 percent in 1919 and still remained as high as 18 percent in 1939.

[22]For clarity purposes, from now I will refer in the general text to both private enterprises and public utilities with the word 'firm'. However, when appropriate for analysis purposes, I will make distinction between the ownership and corporate structure.

and the Electricity firm of Alko Oy Rajamamäki Works, the government owned monopoly of alcohol production, both of which were founded in 1889.

Figure 10: Electric light was first used in Finland in Finnlayson's textile factories in Tampere. Photograph from the Finnlayson factory floor at year 1900. Source: Vapriikki Museum, City of Tampere.

The first *entry episode* of the industry, depicted in Figure 11, commenced with the establishment of the industry at the end of 1800s and was at its strongest between 1918 and 1931. This period follows the country's declaration of independence at the end of 1917. The first entry episode was ended by the Great Depression, which had already started in Finland in 1931. As a result of the Great Depression, the gross domestic product in Finland fell by more than 4 percent between 1929 and 1932 (Hjerppe, 1989), which also affected to the electric power industry of the country. It was common for these first firms in the industry to be vertically integrated. Thus they covered the whole value chain from electricity generation to distribution and retail.

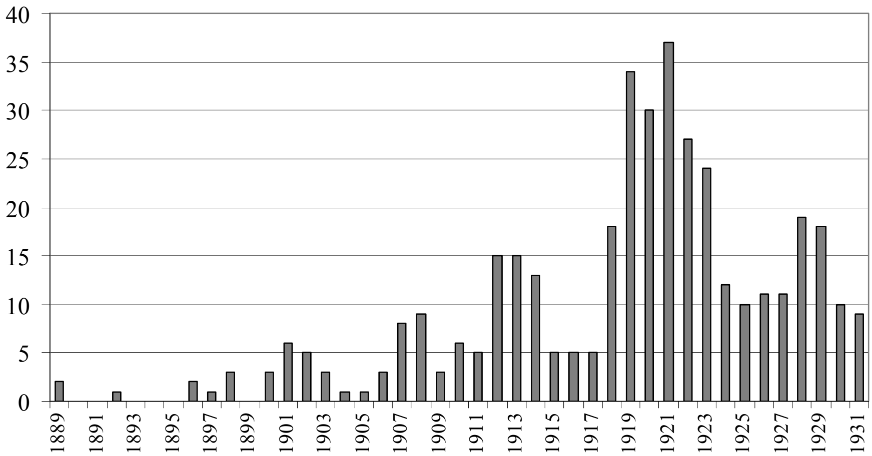


Figure 11: Number of new electric power firms by year, 1889-1931. Source: Finnish electricity statistics 1930-2005.

However, the diversification of the electricity business already started on a small scale at the beginning of the 1900s. Some firms specialized in power generation for industrial usage and were often owned by these industries, whereas others concentrated on power distribution and sales to consumers. There was a lively debate about private and municipal electric firms in Britain and on the European continent at the turn of the century. In Finland, as in the other Nordic countries, municipal electric utilities were regarded as a part of the local infrastructure; moreover, they were seen as vehicles to attract new firms to the town. These municipal owned firms concentrated on building local distribution networks: urban areas and nearly half of the rural households in Finland were wired to an electricity network by 1940 (Myllyntaus, 1991). On the other hand, industrial customers were often outside the distribution network of the cities and as there was no nationwide transmission network connecting the power generation plants and the end users; there was no real market for electricity during the beginning of the period. For this reason the newly established industrial firms had to build and invest in their own power generation plant and distribution network in and around their industrial plants. Right from the beginning of the history of the industry these investments were made by establishing private electricity firms, often owned by the industrial 'customer'. These two early trends – urbanization and industrialization – and the related constraints of market establishment, built a strong basis towards municipal and industrial ownership of electric firms.

The main technology for power generation at the beginning of this period was thermal power. However, harnessing Finnish rivers for hydroelectric power started to grow at this phase. The water law of 1902 gave, to the owner of the water rights, the right to build hydropower plants. This meant a major change in the ownership of the electric utilities as many of the major rivers, their rapids, and the surrounding land areas were owned by the government. Following the water law legislation the Finnish Parliament decided in 1921 to build a hydropower plant on the river Vuoksi in Imatra (see Figure 12).

Figure 12: Imatra hydropower plant was brought into use in 1929. It more than doubled Finland's existing electricity production capacity. Source: Fortum.

This power plant led to a radical change in Finnish electricity supply, more than doubling the country's existing production capacity. To fully utilize the new production potential, it was necessary to construct some 400-600 kilometers of transmission lines across the country (Myllyntaus, 1991). Building the Imatra power plant and the affiliated transmission lines changed the ownership structure of the electric utilities because the Finnish government was introduced to the industry as a major owner of electric power firms. This built the basis of the largest firm in the industry at the end of the observation period, Fortum. The firm has its origin in this phase, when Imatran Voima Oy (IVO) became a limited company in 1923. At this phase IVO also had the responsibility for building the Imatra power plant and the affiliated long-distance high-voltage transmission lines in Finland.

At the institutional level of the society the key events were the declaration of independence in 1917 and the subsequent civil war in 1918. Finland made its first law for the electric power industry at the beginning of this period. According to the Electricity Law of 1901, the electricity business was made subject to license and to be under supervision. The other key events in the other legislation between 1889 and 1939 were mainly associated with the Water Laws and the rights of using water areas such as rivers and watercourses for hydropower generation.

In sum, the key characteristics of the first period in the life course industry were (1) the high number of firm entries and the (2) coevolution with Finnish society, especially with the municipalities and the gradually emerging new industrial economy. Moreover, the seeds of path dependence were sown during this period in the form of ownership structures, utilization of technology, especially hydropower, and the related property rights.

6.1.2. Period 2: Institutionalization 1939-1970

The continuity of the events and activities during the first period – characterized by positive development, firm entries and gradual increase in electricity consumption and utilization in society – ended abruptly at the Second World War. The war was a clear environmental shock not only to the electric power industry but to the whole of Finnish society and started a new period in the history of the industry. This can also be seen in the number of electricity. The Second World War hit the electric power industry massively, more than any other industry in Finland. In the electric power industry, 17 percent of the electricity production capacity was in the areas ceded to the Soviet Union in a truce agreement by the end of 1939. In addition German troops destroyed three medium sized hydroelectric power plants in Lapland between 1944 and 1945, and numerous distribution networks were bombed during the war. Moreover, there was an overall decrease in the consumption of electricity during the war (Myllyntaus, 1991).

Although the development of Finnish society accelerated after the war, the share of agriculture remained high for two decades. During 1950, the share of agriculture of the total labor force in Finland was 40 percent accounting for 16 percent of the GNP (Hjerppe, 1989). This was partly due to the massive support from the government to carry out electrification of the rural areas in order to improve the life conditions and productivity in the countryside after the war. The electrification was based on the guidelines of the two Countryside Electrification Committees in 1947 and 1965 (Pylkkänen, 1982). The consequence of the countryside electrification was that there was a high number of rural distribution electricity firms established in the country. However, simultaneously industrial production continued to increase, mostly concentrated around the forest industry (Hjerppe, 1979). There was a clear dominance of forest industry firms among the largest industrial firms in Finland. Furthermore, the early large forest industry entrants firms still existed in 1979, either independently or as part of larger forest industry enterprises (Hjerppe, 1979). Compared to agriculture, the forest industry had a high demand for electricity as did the other growing industries. For example in 1950, forest industries possessed 53 percent of the total installed industrial power. As a consequence of countryside electrification and the increased need of electricity in the industry – and in the forest industry in particular – electricity consumption continuously increased during the period. Moreover, the regulation of electricity prices kept the price of electricity low compared to other energy sources (Kuusisto, 1973).

The data show that at the beginning there was a trend that those industrial firms, which needed a significant amount of electricity for their production, built their own power plants close to their production plants in order to satisfy the plant's need for electricity. Thus many of the new firms in the industry were those that can be called industry specific. On the other hand, new firms with several industrial owners were also introduced. Two major firms, Pohjolan Voima (PVO) and Teollisuuden Voima (TVO), were established during this period. PVO was established at the beginning of the period, in 1943, and TVO at the end, in 1969, building a basis to satisfy the forthcoming increasing demand in the next phase. PVO's founder shareholders were seven Finnish forest industry firms. The major shareholders of PVO have remained the same: in 2005 these major shareholders were the largest Finnish forest industry firms, UPM-Kymmene (43% of shares) and Stora Enso (16%). The rationale behind establishing PVO was demand-based scale economies; therefore it was an important structural milestone in the evolution of the market: increasing demand from industrial users demanded new larger entities to be built for the first time. A third interesting phenomenon during this period was that the Finnish government continued to establish new firms in the electric power industry by concentrating on harnessing the rest of the Finnish rivers through the building of hydropower plants. Among the largest government owned firms were Oulujoki Oy, established in 1941 and Kemijoki Oy, established in 1953.

In summary, the key characteristics and events of the second period during the evolution of the Finnish electric power industry were (1) the coevolution of the industry with the forest industry and the consequent establishment of two major power generation firms PVO and TVO owned by the forest industry, (2) the government support for countryside electrification and the subsequent increase in the number of rural distribution electricity firms.

6.1.3. Period 3: Increasing demand 1971-1994

The total number of firms continued to increase during the previous period until 1970 by which there were a total of 557 firms in the industry. However, during 1971 and throughout the subsequent years the total number of firms started to decrease for the first time since the Second World War. These events started a new period in the industry. The greatest fall in firm numbers was between 1970 and 1975: the number of firms decreased by 25 percent, from 557 to 417, over that five years period. The industry had never before seen such a high level of consolidation. A notable event in Finnish society during this period was the countrywide recession between 1974 and 1979 which was a consequence of the worldwide Oil Crisis, which started in 1973. At the same time as the significant decrease in firm numbers the demand for electricity continued to accelerate, with an exception of 1971 when there was a major strike, even though this included the years of overall economic recession. The major reasons for the increased consumption were the increased demand for electricity heating in houses and the overall economic boom in Finland before and after the years of recession. Moreover, the regulation of electricity prices continued to keep the price of electricity low compared to other energy sources. The analysis of the data shows what happened through mergers and acquisitions. Thus the assets of the firms, the power generation plants and distribution networks remained in the industry. The reasons behind the mergers and acquisitions were twofold.

First, as the result of increasing demand there was a major need for investments in all parts of the value chain from power generation to distribution. Firms with a larger asset base and wider ownership base (either municipalities or other industries) had better financial opportunities to engage in the needed new investments. Moreover, the investments required new technology and political will. Thus the established firms and particularly those having close relationship with the major industries or local and central government had a clear advantage during this phase. The call for new production capacity, which had already started at the end of the previous period or in the 1960s, was covered by thermal power mainly using oil as a raw material. Consequently, the share of oil in all energy consumption in Finland had grown from 35 percent in 1963 to 62 percent by 1973 (Numminen, 1984). As the path of harnessing the rivers for hydropower had in practice come to an end, and the Oil Crisis in 1973 had massively raised the cost of oil as the raw material for electricity, the industry had to find new energy sources to fit the increasing requirements of industry and society. Nuclear power was a tempting alternative. However, building nuclear power required both a political decision and also substantial investments. The firms having both these capabilities were IVO and the newly established TVO. The latter included PVO and IVO - and through them the Finnish government and the forest industry - as major shareholders. Eventually, four nuclear power reactors were commissioned and built and they were taken into service between 1977 and 1981. IVO built the first nuclear power plant in Finland, Loviisa I, which commenced operation in 1977, and finished the second reactor, Loviisa II in 1980 (see Figure 13). TVO completed its nuclear power plants at 1978 and 1980. Nuclear power rapidly became one of the major energy sources in Finland, with a 34 percent share of gross production in 1990 and 25 percent in 2004. Most of the requirements of oil as an energy source for power generation before the Oil Crisis was covered by nuclear power, so that the share of oil in all energy consumption in Finland had decreased to 47 percent by the end of 1983 (Numminen, 1984).

The second explanation for the mergers and acquisitions was that numerous small electricity distribution firms that were established during the previous high entry period due to the government supported countryside electrification ran into financial difficulties squeezed between government regulated electricity price freezing and the increased price of oil as production raw material for their oil based thermal power plants. Moreover, based on the recommendations of the Countryside Electrification Committee, the Finnish government gave subsidies for rural distribution firm mergers in order to increase the security of supply by forming larger and more stable asset bases.

Figure 13: Loviisa nuclear power plant represented the first use of nuclear power technology in Finland. Source: Fortum.

The high involvement of the Finnish government and the forest industry in the electric power industry strengthened during this phase through their ownership arrangements. At the end of the 1970s the largest firms owned by the Finnish government were Rautaruukki, Enso-Gutzeit, Kemijoki, IVO and Veitsiluoto (Hjerppe, 1979). Two of these – Enso-Gutzeit and Veitsiluoto – were forest industry firms, IVO and Kemijoki were electricity firms, and Rautaruukki represented the metals industry – which also demands high requirements for electricity. Thus the role of government for the electric power industry was threefold. First, it exercised power over the industry through formal institutions: legislation and regulation. Second, it acted as a major player and investor in the industry with dominant firms under its ownership. These government owned firms thus made use or their status and capabilities – financial strength, property rights and political support – to gain dominance in the market by utilizing two key technologies in the industry; hydropower and nuclear power. Third, the Finnish government had a secondary role – as a major owner of forest and other major industry firms – in the coevolution of the electric power industry and the other key industries in the country.

6.1.4. Period 4: Deregulation 1995-2004

Although there had been different ownership models for electric power utilities not only in Finland but all over Europe, the telephone, post, railways and electricity industries among others, were widely considered as municipal or government infrastructures. However, in many European countries the perspectives towards the ownership of these industries changed from the mid 1980s onwards. The EU Commission affected this development via the 1990 Transit Directive. This led to gradual electricity industry deregulation throughout Europe. The deregulation started in 1990 when the UK electricity market was liberalized through denationalization. The process continued in the Nordic countries during the 1990s: in Norway deregulation started in 1991, in Sweden in 1996 and in Finland from 1995 to 1998. In Denmark the market has remained strongly regulated.

In Finland, the Electricity Market Act, which entered into force in 1995, opened the Finnish electricity market to competition. In the initial stage, only the major electricity users were allowed to invite tenders from electricity suppliers. During the next three years the market was gradually liberalized so that by the beginning of September 1998households were also able to choose between competing electricity suppliers. Thus the year 1995 started a new period in the electric power industry in Finland. The electricity market reform removed obstacles to competition and unnecessary regulation in the sectors of the market where competition was possible, i.e. generation, sales and foreign trade. On the other hand, clear rules of the game were established for electrical power networks that operate as a natural monopoly (Sener, 2000). The deregulation also changed the structure of the industry. As the sale of electricity was liberated, new firms concentrating solely on electricity sales entered the market. The deregulation also opened the market to international entrants. The major international entrants were the government owned Swedish market leader Vattenfall, and E.ON from Germany, which also had historically been a monopoly in Germany and owned by the German government. The characteristics of these entrants were that they did not primarily enter into the retail market targeting organic growth. Nor did they start investing to power generation. Rather, what they did was that they acquired existing firms thus providing them with the existing infrastructure of the Finnish market.

The exit period that had already started during the former period continued during this period. Within two years after the start of deregulation, between 1995 and 1997, the number of firms decreased by 16 percent from 328 to 276[23]. According to Gunther (2002), 49 acquisitions were carried out in Finland during 1999-2001.

[23] Jyllinkosken sähkö is an illustrative example of rural electricity distribution firm acquisitions. The firm was established in 1921. The operation started with the building of a hydropower plant in the Jyllinkoski rapid. Initially the electricity was distributed to only two municipalities, but this was extended to cover 18 municipalities by the end of the 1980s. The majority owners were the municipalities of the north-western coast of Finland. The firm participated in market consolidation starting from the 1960s by acquiring a total of 116 electricity co-operatives and distribution firms between 1960-1989. Lounais-Suomen sähkö acquired 54 of the shares of Jyllinkosken sähkö 25th of April, 1995, just before the Electricity Market Act came into force. The firm was finally merged to form Lounais-Suomen sähkö during 1996. Länsivoima (former Lounais-Suomen sähkö) was further acquired by Fortum in 1996. A picture of the share certificate of Jyllinkosken sähkö is in Figure 14.

Assets worth more than 4.5 billion euros were restructured while foreign firms were involved in 8 of the 15 largest transactions. At the same time 88 percent of all municipal electricity firms were converted to limited companies. However, compared to the previous period, during which the decreases mainly happened due to firm exits as a result of mergers and acquisitions, this period was also characterized by numerous firm entries. This changed the structure of the market: new firms entered the market, and former utilities were changed to limited firms, with some becoming specialized local monopolies of electricity distribution, and others concentrating on electricity sales in the new competitive market. Illustrative

1 1

OSAKEKIRJA

N:o 332983

20 mk sarja A 1883

on maksettuansa

JYLLINKOSKEN SÄHKÖ OY

nimiseen osakeyhtiöön yhden osakkeen täyden määrän

KAKSIKYMMENTÄ MARKKAA

saavuttanut vastaavan osuuden yhtiössä niillä oikeuksilla ja velvollisuuksilla, jotka sen vahvistettu yhtiöjärjestys lähemmin määrää.

Kurikassa 1 p:nä syyskuuta 1982

JYLLINKOSKEN SÄHKÖ OY

1 1

Figure 14: Share certificate of Jyllinkosken sähkö. Source: Pörssitieto Ky.

Another interesting new phenomenon in the Finnish electric power market was the change of the boundaries of the market. In wholesale, the country-limited boundaries had in practice gone and the market had grown into a Nordic market. This was enabled by the development of spot markets[24] for electricity, where producers, distributors and large end-users could trade electricity, for example on a day-ahead basis.

Deregulation started another *entry episode* in the history of the electric power industry in Finland in terms of number of firms. The key statistics described in Table 10. However, the number of new firms reflected the changes in the legislation leading to industry restructuring rather than a flow of totally new entrants to the industry. The electricity distribution, retail, and power generation operations were divided according to the law as separate legal entities as will be discussed in detail later. The result was that total 23 new power generation firms and 16 new electricity retail firms were established between 1995 and 2005. However, a notable new development was the establishment of the first wind energy generation firms in Finland during this episode: eight new wind energy firms were established between 1995 and 2005. Even though the volume of electricity produced with this new technology was extremely low compared to the existing technologies, it represented an interesting new technology that was to be introduced to the industry.

As the history of the electric power industry in Finland indicates, the overall industry evolution- industry structure, competitive dynamics and individual firms - were impacted by the surrounding society and by embedded institutions, the available power generation technology and the firms in the industry.

[24] The Nordic wholesale spot markets are run by NordPool, the Nordic power exchange, which was established in 1993 and now serves all of the Nordic countries. NordPool was created with the key firms and with the backing of the Nordic governments and their relevant authorities.

Table 10: Number of new firms by business model 1995-2000. Source: Finnish electricity statistics 1995-2005, Adato Energia and Finnish Electricity Market Authority.

Segment	1995-2000	2000-2005	Total 1995-2005
Distribution	5*	4	9
Power Generation	8	15	23
Power Generation (Wind)	7	1	8
Forest Industry	4	1	5
Other Manufacturing	3	1	4
Other Industry	1	1	2
Electricity Retail	10	6	16
All Sectors	38	29	67

** Regional Distribution*

Thus, following the research framework (Figure 6), the evolution of formal institutions – public policies – and their impact on the industry evolution and on power generation technology and firm business models in particular, will be elaborated in the next section. Thereafter, the evolution of power generation technology and firm business models will be analyzed. These detailed analyses are essential in order to identify the key events in the different levels of analyses and their proximate causes during the evolution of the industry. Thus the following sections build a basis for the final causal event analysis of the industry.

6.2. Evolution of public policies

The impact of Finnish public policies on the electric power industry in Finland and on the electric power firms can be categorized into three areas of impact: direct electricity market legislation, legislation of ownership rights, and legislation of prices. The analysis of the legislation shows that the regulation and legislation was powerfully used in Finland throughout the period of evaluation to direct the electric power industry according to objectives of the surrounding political institutions of the state. A summary of the main events in the evolution of legislation in Finland that affected the electric power industry during the period of review is presented in Table 11. Following the periodical division introduced in the historical analysis of the industry of the previous chapter, I have divided the detailed analysis of the legislation into three groups, the first one covering the first period of the life course of the electric power industry, the second covering the following two periods, and the last covering the fourth period after the market deregulation in 1995.

6.2.1. Electricity Laws 1901 and 1928 and other key events 1889-1939

The first electricity law was passed as early as 1901. According to the law electricity business was made subject to license and under supervision. The evolution of the legislation between 1889 and 1939 was mainly associated with the right to use water areas such as rivers and watercourses for hydropower generation. The fundamentals for these rights were laid out in the Water Act in 1902. Building hydropower plants was made subject to license to be appealed for from the Water Rights Court. In 1919 a law to prevent transmitting of electricity over Finnish borders was passed in order to prevent foreign investors from utilizing Finnish hydropower resources in order to generate electricity to be further transmitted to other countries. In this regard Finland had become an independent state at the end of 1917 after having being an autonomous Russian Grand Duchy. As Myllyntaus (1991) stated, this new law was passed to prevent transmission of electricity to Russia from the power plants that were still under Russian ownership. This kind of lawmaking indicates that the hydropower resources of the country and the related power generation were considered as important national resources. These early trends built a basis for a view that the electric power industry is to be a national business with national ownership. This way of thinking only changed in the 1990s concurrent with the overall changes in mindset regarding what counts as national borders because Finland was planning to join the EU. In the legislation the constraints of foreign ownership was finally liberated in the Electricity Market Act in 1995.

The second electricity law was passed on May 11th, 1928. The main new content of the law was regulation of electrical safety. However, from the point of view of the evolution of the electric power industry's ownership structure there was one notable section in the law: the law gave the municipal councils a right to refuse the building of electricity distribution networks within the boundaries of the municipality.

Table 11: Main events in electricity legislation during 1889-2005

Period	Year	Law or other event	Main implication to electricity firms
1.	1901	Electricity Law[25]	Electricity business was made subject to license and under supervision.
	1902	Water Act	Definition of the rights of ownership of water areas.
	1917	The Commission for Hydropower[26]	Planning of the construction of government owned hydroelectric power plants. Built a basis for the government owned firms.
	1919	Law of transmitting electricity over Finnish borders[27]	No one is permitted to transmit electricity generated with indigenous energy sources over the Finnish border.
	1928	Electricity Law	Definitions of electricity security.
2.	1940	Act of temporary licenses[28]	Temporary licenses could be granted for regulations watercourses before the final permits were granted.
	1941	Emergency Act for power plant construction[29]	A power firm, which possessed a building site and at least two-thirds of the hydro potential of the rapids could be granted temporary license to build a power plant before the final decision.
	1947-1950	Countryside Electrification Committee	A plan to electrify the countryside or the rural areas of Finland. Price regulation and government subsidy to build electricity networks and power plants.
	1950	Power Law	Electricity price freezing
	1961	Water Act	Definitions of who was entitled to build a hydropower plant and on what conditions.
	1965-1966	Countryside Electrification Committee	Price regulation and government subsidy to build electricity networks and power plants. Government subsidy to facilitate small rural distribution firm mergers.
	1968	Power Law[30]	Electricity price freezing
3.	1973-1974	Electricity Distribution Organization Committee	Proposal that small electricity distribution firms should be merged with each other or with the larges ones. Proposal of an electricity distribution planning system.
	1979	Electricity Law	Set up of an electricity production and distribution planning and control system.
4.	1995	Electricity Market Act	All users with a power demand exceeding 500 kW come within the scope of competition
	1998	Electricity Exchange	The Nordic electricity exchange, NordPool, starts operation in Finland.
	1998	Load profile method in balance clearing	All small-scale users (with a main fuse max 3x63 A and a power demand of max 45 kW) are allowed to benefit from competition without the obligation to use hourly metering

[25] ”Laki sähkölaitoksista valon synnyttämistä tahi voiman siirtoa varten, (1901)”
[26] ”Koskivoimatoimikunta (1917)”
[27] ”Laki sähkövoiman siirtämisestä maan rajojen ulkopuolelle, (19/1919)”
[28] ”Laki eräiden vesioikeusasiain poikkeuksellisesta käsittelystä, (383/1940)”
[29] ”Laki toimenpiteistä vesivoiman käyttöön ottamisen helpottamiseksi. (196/1941)”
[30] " Päätös hyödykkeiden hintasäännöstelystä (196/1968)"

This caused a trend that, particularly in the cities, the electricity distribution was owned by the municipalities and thus many privately owned firms made an exit from the market (Karjalainen, 1989). According to Myllyntaus (1991), the Finnish laws and their tightly national interpretation were used to slow down and even prohibit direct foreign investment in the hydroelectric plants and in the distribution utilities prior to the year 1940. In addition, the legislation postponed the hydroelectric projects before the Emergency Act in 1941.

Two key acts, the Act for Temporary Licenses for Building Hydropower Plants (1940) and the Emergency Act for power plant construction (1941) were passed to enable and catalyze the reconstruction of the distribution networks and to build new capacity to cover the losses in the county's overall power capacity that occurred due to the loss of ower plants that had been ceded to the Soviet Union during the Second World War.

The collaboration between the authorities and industrial life already produced institutionalized forms after the First World War, when the regulation of the country's economy became unavoidable. Accordingly, the Senate of Finland established a Trade and Industry Commission in 1918, which received the authority to regulate the economy: "…because the Commission has to interfere quite much the rights to be engaged to a trade, the goal was to get the industries as much as possible involved to the organization and management of the Committee for them to be disposed to it with trust (Ruostetsaari, 1989:208)."

In summary, public policies already impacted on the evolution of the electric power industry during the first years of the life course of the industry. Direct legislation, such as electricity business licensing and secondary policies, for example water rights, defined or directed the evolution of the industry; exploitation of technology, and firm business models and ownership structures. The reciprocal relationship between the public policy makers and the industry – or in other terms the coevolution between the public policies and the electric power industry had already started at this phase. Moreover, the early legislation had far-reaching efforts due to their combined impact with firm-level evolutionary path dependence, as will be shown later in the analysis.

6.2.2. Electricity Law 1979 and other key events 1940-1995

The early trend of collaboration between the authorities and the major industries after the First World War was followed by the collaborative actions of the controlled economy[31] during the Second World War (Ruostetsaari, 1989). Accordingly, as the Electricity Law (1928) became partly obsolete during the following decades, it was particularly the regulations of licensing which could not be fully complied with. There were already attempts to create new electricity law in the 1950s, but this did not lead to new electricity legislation. However, flexibility between the authorities and the electricity firms enabled a positive development of the industry (Kunnas, 1982). The institutionalized forms of collaboration were left in the background after the Second World war; the growth of the economy turned relations between the government and the electric power industries to more competitive status, which were seen as 'rapid wars', and competition of nuclear power rights between the private owned power generation firm (mainly TVO and PVO) and the government owned firms (IVO, Kemijoki and others) (Ruostetsaari, 1986). However, after the Oil Crisis and the related overcapacity, the threat of increased government regulation led to a revival of the close collaboration between the government and the private and government owned electric power firms[32] (Ruostetsaari, 1989). All in all, there are three notable examples of the coevolution of public policies and the electric power industry

The collaboration to provide the war indemnities[33] after the Second World War,

[31] A Ministry of National Welfare (kansanhuoltoministeriö) with representatives from the key industries was established in Finland, when the Second World War was seen as very probable (Ruostetsaari, 1989). This kind of collaboration trends were prevailing also in many other countries (Victor, 1984).
[32] This collaboration got institutionalized forms, when the Power Producder's Co-operation Delegation (Sähköntuottajien Yhteistyövaltuuskunta) was established in year 1975.
[33] A Delegation of War Indemnity Industries (Sotakorvausteollisuuden valtuuskunta, Soteva) was established after the Second World War to co-ordinate the war indemnities to Soviet Union. The delegation got wide authorities and autonomous authorities (Ruostetsaari, 1989).

brought institutionalized forms during the evolution of the Finnish economy in the 1900s and thus built a basis for a close and institutionalized collaboration between the government and industrial life. After the Second World War, the settlement of the inhabitants from the ceded areas, war indemnities, and the reconstruction of the country after the conflict caused all the resources of the country to be mobilized. In addition life conditions for the people in the rural areas had to be improved (Pylkkänen, 1982). Electrification was one of the means to improve the life conditions and productivity in the countryside. As a consequence, the first Countryside Electrification Committee[34] was appointed by the government of Finland on January 30th, 1947 to develop a plan to carry out electrification of the countryside and rural areas of Finland. The Committee made recommendations regarding price regulation and government subsidy to build electricity networks and power plants. Based on the recommendations, the electricity connection and basic fees were according to the possibilities of using electricity; for example it was based on the number of rooms in houses and on the arable area of the farm (Pylkkänen, 1982).

As a result of countryside electrification 260,000 new retail electricity customers entered the market between 1947 and 1960. A substantial number of electricity distribution networks had to be built to connect these new customers to the national electricity transmission network. New power generation capacity had to be built to fulfill the latest demand. Within the electric power industry there were two major consequences of this public policy action. The first of these consequences was that numerous new urban electricity distribution firms were established. Government did not participate to their ownership. The new firms were either private co-operatives or owned by the local municipalities. The second consequence of the public policy action was that thermal technology was mainly used to fulfill the new electricity demand and consumption. The reason for this was that thermal technology was widely available and the raw material costs were reasonable. In addition, the former

[34] "Maaseudun sähköistyskomitea"

water rights restricted the use of hydropower technology.

The Power Laws and subsequent electricity price regulation in 1950 and 1968 is the second example of how coevolution of public policies had a notable impact on the evolution of the electric power industry. The first Power Law[35] in 1950 impacted the electric power industry through price regulation, which in turn had an impact on the profitability of the electricity firms. The Power Law and price regulation were struck down in 1955, which led to significant price increases and to a general strike in 1956. After that, a second Countryside Electrification Committee[36] was appointed by the government on January 28th, 1965. It proposed price regulation in order to subsidize the building of rural electricity networks. The synergetic impact of initial investment burden and the price regulation caused financial and operational challenges to the newly established firms, which was also reflected in their service level towards customers. Thus the service reliability of the electricity distribution firms established as a consequence of the first Countryside Electrification Committee was recognized to have not fulfilled the customers' needs. For this reason the second Electrification Committee recommended that the ownership of the distribution firms should be broad-based. The committee also proposed a government subsidy to facilitate the mergers of small rural distribution firms.

Although the government did not pass a law of electricity subsides, as proposed by the Committee (Pylkkänen, 1982), it agreed with the propositions and made provision for de facto government subsidies for the coming years. Moreover, in 1972, an Electricity Distribution Organization Committee[37] was set up "because the importance of electricity has increased substantially in all branches and the consumption of electricity has largely increased also in private households. Thus it is considered to be justified to start to investigate, whether an improved service level for the private consumers could be gained through centralization of electricity

[35] Valtalaki
[36] "Maaseudun sähkökomitea"
[37] "Sähkönjakelun organisaatiotoimikunta"

distribution activities into larger entities all over the country." After the investigation the committee argued that "the impact of small electricity distribution firms that operate in a small-scale is harmful to the national ensemble of electricity distribution" and that "a larger size of electricity distribution firms should be targeted". As a consequence, and as stated in the editorial of the annual report of year 1972 of the Electricity Utility Association there was "ongoing voluntary branch rationalization in a form of mergers of small electric distribution firms either to larger ones or among each other".

The third notable example or coevolution of public policies and the electric power industry concerns the further Power Law of 1968, according to which the prices of electricity could be revised only by to the decision of the price authority (Nurmo, 1973). This led to electricity price freezing between 1968 and 1972. Without some exceptions the price of electricity remained the same during the period (Simonen, 1974). An Electricity Price Commission[38] proposed in November that either the distribution tariffs should be abolished or the profitability of the electricity distribution firms should be guaranteed in some other way. The result was that the distribution electricity prices were not fully abolished, but rather were increased by close to six percent from the beginning of 1973 (Kuusisto, 1973). However, during the same time period the price of raw material, mainly oil and coal had increased substantially. An Electricity and Heat Tariff Committee[39] calculated that the need to increase electricity prices in 1974 from the 1973 level due to the real increased production costs was 70 percent (an average consumer price increase from 13,6 p/kWh to 23-24p/kWh). The declaration of several stakeholders concerning the Committees' proposal highlighted that the simultaneous production cost increase and the price regulation had caused severe financial and operational challenges for the electricity firms, particularly for electricity distribution firms and firms exploiting thermal power generation technology. As a consequence, the government increased the price of electricity for consumers by 51 percent (7 p/kWh) starting

[38] Sähkönhintatoimikunta
[39] Sähkö- ja lämötariffitoimikunta

from May 1st, 1974.

The increases of electricity productions cost as a result of the Oil Crisis started a process that impacted electricity legislation. According to Ruostetsaari (1998:28) the shocking Oil Crisis "can even be seen as a catalyst, which initiated, when analyzed retrospectively, the deregulation of electricity markets in many countries". He argued that the crisis brought energy to the political agenda and motivated political decision makers and authorities to interfere with the electricity industry through legislation and regulation in order to ensure the undisturbed delivery of energy. Consequently, increased political interest and government actions augmented the co-operation of the actors in the electric power industry. Although there had been an intensively increasing demand for electricity in the market there had not been much co-operation between the government owned power generation firms and the electricity firms owned by the privately owned industrial firms during the second period. This was seen as 'rapid wars' and competition of rights to build nuclear power. The reason for this was that the privately owned firms wanted to keep the price of electricity suppressed and were afraid of the dominance of the government owned firms whose wish was to lead increases in prices. However, co-operation started after the Oil Crisis. In 1975, A Co-operation Delegation for Electricity Producers[40] was set up. The goal of this body was to co-ordinate electricity production and distribution before the government would take its own action (Ruostetsaari; 1998, 2005).

Consequently, the third electricity law in Finland was passed on March 16th, 1978 and came into effect from the beginning of 1979. The new law had four key changes. First, its purpose was to intensify the planning of electricity generation, transmission and distribution both at the national and regional level. An electricity supply planning and control system was set up for both national and regional levels. Second, it improved the possibilities for government and the municipalities to

[40] Sähköntuottajien Yhteistyövaltuuskunta, STYV

develop the planning organization. Third, it made electricity firms and utilities subject to license. Fourth, it gave the power of decision to build power plants or electricity networks for the government. The electricity generators opposed the new law, but it was viewed as the price to prevent the whole industry to be nationalized, as proposed by the Industrial Committee in 1974, and as in was the case in many other western countries (Ruostetsaari, 2005). However, as Ruostetsaari (1998) argued, although the new electricity law included several new regulations, it did not indicate a start of an era of new control and regulation, but rather it indicated a last feat of strength of the long-lasting institutionalized control ideology.

Until 1988, when the legislation on restrictive business practices was effective, there was a price supervision procedure: there was an obligation to disclose price increases to the government. Price increases were possible, it the government permitted them. In the years 1988-1995 the intervention to the prices was removed from the government. However, the new Office of Free Competition was given rights to engage in electricity pricing when appropriate. The energy legislation and regulation was the result of the overall governmental energy policy[41] in Finland. Ruostetsaari (1989) studied the determination of Finland's energy policy in the light of distribution of influence over energy policy in the 1980s. He found that there was a top elite that had stipulated the energy policy in the country during this time, and indeed had been ruling it for a longer period. The four top influential actors were the Ministry of Trade and Industry, IVO, Neste (a state owned oil and gas firm, which was merged with IVO in the late 1990s), and the Central Association of Finnish Industry. According to Ruostetsaari (1989) the energy industry and the other major industries had a considerable influence over Finland's energy policy – which was even stronger during the decades before 1980s. He found five reasons for the domination of the elite. The first reason was that energy research was largely concentrated in the energy production firms. Therefore, energy research tended to reinforce those with the resources to engage in research and who could take

[41] Energy policy is seen here to include all the public policies from basic underlying principles to formal policies, such as legislation and electricity tariffs.

advantage of the results. Second, the mass media did not form a distinct opposition to the energy elite. The third reason was that the political parties' positions on energy policy were shaped in technocratic and even bureaucratic processes. Fourth, the top elite firms had gained a clientele-type of relationship with the Ministry of Trade and Industry as the natural representatives of their respective industries. And the final reason was due to the long-term coevolution between the actors. Or as Ruostetsaari (1989) puts it: "Over the decades the interaction between energy administration and energy policy's top elite has developed into a reciprocal relationship based on mutual benefit; therefore it is obviously not easy for new actors to join the established system. This has tended to crystallize power relations, which has resulted in the development of mechanisms of negative selection: these serve as sort of filter eliminating the entry of interest and demands which might upset the stability of the system" (1989:406).

Ruostetsaari's (1989) research, and the conclusions contained therein, thus supports the other findings of long-term coevolution between the electric power industry, the other major industries – and the forest industry in particular, and with the government. Moreover, the impact of the top elite is clearly causal and purposeful. Furthermore, Ruostetsaari's (1989) findings confirm that the evolution of technology in the industry was in many cases also causal due to the influence of the institutional subsystems around specific energy sources.

To summarize, there were several public policy events during the period between 1940 and 1995 that had an impact on the evolution of the electric power industry in Finland. What is notable is that these events were often related to the overall evolution of the national society; the countryside electrification actions were outcomes of the Second World War, the price regulation in the 1950s and 1970s were due to the overall general national economy, and the Oil Crisis in 1973 was a global level shock. Nevertheless, all of these impacted directly on the firms in the electric power industry – and with different impacts to firms with distinct business models. A further noteworthy matter is the reciprocal relationship between public policy makers and the electric power industry – not least because most of the members of the numerous energy-related committees during this period were the managers of the electricity power firms. Furthermore, this period highlights the need for reconstructive public policies. For example, the countryside electrification actions caused numerous small electricity distribution firms to be established. As a result of the impending evolution of the industry these firms ran into operational and financial difficulties. Consequently, the government had to take reconstructive action in the form of recommendations and subsidies to merge the small distribution firms.

6.2.3. Electricity Market Act 1995 and other key events 1995-2005

The preparation work for deregulation and reform of the electric power industry started in November 1990, when an Electricity Utility Committee[42] was set up. The committee gave its report in February 1992. It suggested that competition should be increased and electricity distribution should be rationalized. The suggestions took into account the fact that Finland was going to apply for EU membership. Immediately after the set up of Electricity Utility Committee another committee, the Electricity Law Committee[43] was initiated in 1993 to prepare a new electricity law for the country. The committee gave its report and suggestions in March 1993. The latter committee proposed that electricity distribution should be legally separated from electricity sales and procurement functions and to also separate them from the other functions of an electricity firm, such as power generation. The Finnish Electricity Utility Association (SLY) commented on the proposal that is was precipitated and unfinished. The association suggested that the markets should be opened in phases according to the country's overall EU development. The Federation of Finnish Entrepreneurs[44] commented in the Kauppalehti finance newspaper in November 1993 that "SLY has badly lobbied against the reform. It is of course understandable, since it is a question of a really radical change, which would likely imply cutting down in the association's field of members." Thus there was evidently a belief that market deregulation would cause firm exits from the

[42] Sähkölaitostoimikunta
[43] Sähkölakikomitea
[44] Suomen yrittäjien keskusliitto

industry. Following the general guidelines of the Electricity Law Committee a proposal for a new law was put forward in February 1994. Following an animated debate the parliament enacted a new law in February 1995. The Electricity Market Act (386/1995) entered into force on 1st of June 1995 and opened the Finnish electricity market to competition. In compliance with the Act, the Electricity Market Authority[45] was established to supervise power network operations and to carry out other public tasks.

The Electricity Market Act had four key contents. The first was that it opened up the electricity sales market to free competition and freed the electricity retail business from licensing. At the same time the exclusive right to sell electricity regionally was removed from electricity retailers. To safeguard the interests of small electricity users an obligation to deliver statement was added to the law[46]. At the initial stage, only the major electricity users whose site-specific power consumption requirement exceeded 500 kW were allowed to invite tenders from electricity suppliers. The introduction of the load profile method in balance clearing in autumn 1998 finally enabled the smaller consumers or households to purchase electricity freely from any supplier. The second key element of the act was that it specified regional distribution firms as local monopolies, which required a network license that was issued by the Energy Market Authority. According to the law, the license holder has the exclusive right to construct distribution networks and connect customers to the network in its geographical area of responsibility and its customers are not allowed to invite tenders for distribution services. Moreover, the network operator has an obligation to maintain and develop the power network, to connect to his network electricity consumption sites and power generating installations and to transmit electricity. The network operator is also responsible for the condition of the network and the quality

[45] The Electricity Market Authority changed its name into the Energy Market Authority in August 2000.

[46] An electricity retailer having a remarkable market power within the area of responsibility of a distribution net operator shall deliver electricity at a reasonable price to the consumers and to other electricity users whose main fuse is maximum 3x63 A and annual consumption is maximum 100,000 kWh.

of the electricity supplied to consumers. The law has also thorough regulation of distribution pricing[47]. The third aspect of the Electricity Market Act was that the law specified unbundling principles between the network operations or distribution business and electricity sales operations. According to the law, the network operations shall be legally unbundled from other electricity trade operations if the amount of electricity distributed in 0,4 kV network has been at least 200 GWh/year during the previous three years. Moreover, on January 1st, 2007 legal unbundling legislation applied to firms with over 200 GWh of electricity distributed in 0,4 kV level.

The reasoning behind government proposal (HE 138/1994) relating to the Electricity Market Act included four key motivations for the new law. First, it referred to the European Union and the forthcoming European integration, and thus the new law was argued that it was to prepare Finland for integrating Nordic electricity market and for the forthcoming integrated European electricity market. Second, it was argued that it sought to remove obstacles to competition. Third, it would remove unnecessary regulation. And finally, it was envisioned that the increased competition would improve the utilization of the electricity production resources and to bring about cost savings for electricity consumers. Although Finland's EU membership was one of the causal events leading to electricity market deregulation, as Ruostetsaari (1998) has remarked, the evolution of the regulation in Finland towards deregulation had already started in the mid 1980s, and would probably have caused deregulation without the EU membership. However, the EU was used as a strong legitimation argument to speed up the legislative process towards deregulation (Ruostetsaari, 1998).

[47] For example, the price of network services must not depend on where within the net operator's area of responsibility the customer is geographically located. Neither can the distribution price depend on which electricity vendor the customer buys his electricity from. In addition, the prices of network services, such as connection to the network, and distribution and metering of electrical energy must be made public, and reasonableness and regional impartiality must be followed in their pricing. It must be possible for the customer to agree on all the network services he needs with the company to whose network he has been connected.

The government emphasized a swift implementation of the changes in the legislation for several reasons. The first of these reasons is that similar legislative changes were under preparation in EU directives. Secondly, there were upcoming changes in the wholesale tariffs and most of the electricity wholesale agreements were to be renewed at the end of 1995. Furthermore, a major transition of organization models and ownership structures of the electricity firms was ongoing in the industry. Thus the decisions of the firms were seen to depend on the new rules of the game defined in the new legislation (Ruostetsaari, 1998). As stated in the reasoning of the government, one of the expectations for electricity supply market deregulation was to decrease the overall price of electricity through competition. The price development between 1993 and 2004 is depicted in Figure 15. Indeed, the prices decreased during the period between 1997 and 2001. However, there was a high peak in the price of electricity in the Finnish electricity market at the beginning of 2003 due to the sudden increase of wholesale price in the new Nordic wholesale market. The reasons behind the increase of wholesale prices were related to a deficiency of water in Norway and a very cold winter in Finland. These two reasons that the government wished to emphasize a swift implementation of legislation change; the decrease of prices due to increased retail competition, and an increase of prices due to shortage of production resources, showed that the principles of the new opened electricity market worked as planned. In addition, the further expectation of deregulation was that it would speed up customers to change their electricity suppliers. However, in the year 2004, only 11 percent of customers had in fact changed their electricity supplier. Moreover, nearly 60 percent of electricity in Finland was bought at a contract price.

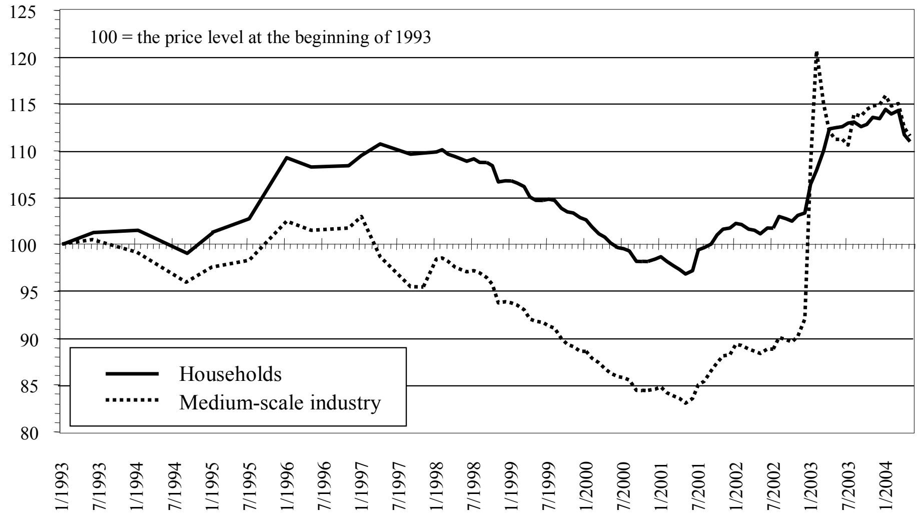


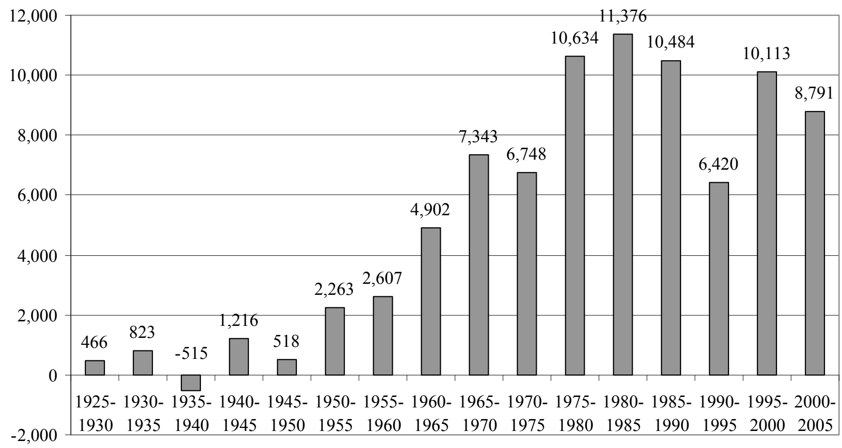
Figure 15: Evolution of the overall price of electricity 1993-2004 (adjusted with Consumer Price Index). Source: Finnish Electricity Market Authority.

In summary, the impact of formal institutions – legislation and regulation – has been substantial on the evolution of the electric power industry in Finland. This impact has been extensive: institutions have impacted the rules of the game in the market, exploitation of technologies, and emergence of distinct business models in the industry and subsequently the survival of individual firms. Moreover, there has been a reciprocal coevolutionary relationship between the electric power industry and related institutions, and surrounding society. Thus, following the logic of the research framework, the evolution of electricity consumption and the power generation technology will be analyzed in detail in the next chapter. Thereafter the evolution of business models of electric power firms will be elucidated.

6.3. Electricity consumption and power generation technology evolution

6.3.1. Electricity consumption evolution

Electricity consumption started on a very small scale in Finland from the first experiments in the 1880s; the consumption in the year 1890 was one GWh. In 1917, when Finland became an independent state, the total consumption was 205 GWh. The consumption has grown steadily so that by 2005 it was close to 85,000 GWh. The total electricity consumption and the five-year growth numbers are presented in Figure 16.



Year	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Consumption (GWh)	1,073	1,896	1,381	2,597	3,115	5,379	7,986	12,888	20,231	26,979	37,613	48,989	59,473	65,893	76,006	84,797

Figure 16: Electricity consumption (GWh) growth in Finland 1930-2005. Source: Finnish electricity statistics 1930-2004.

The proportional growth was greatest in the inter-war period, but both the production and the consumption radically decreased after the Winter War when 17 percent of the electricity production capacity was held in the areas lost to Soviet Union at the end of 1939. The net growth was the largest between 1980 and 1985 – a total of 11,376 GWh. This was a period in which the magnitude of the growth was substantial and growth alone was at the same level as the total consumption some twenty years earlier – in 1963, when the total consumption was 11,058 GWh.

Table 12: Electricity consumption in Finland 1930-2004 by segment. Source: Finnish electricity statistics 1930-2004.

Segment:	Private		Services*		Public		Manufacturing		
Year	GWh	% of Total	GWh	% of Total	GW h	% of Total	GWh	% of Total	Total
1930	78	7,3 %			29	2,7 %	967	90,1 %	1 073
1935	103	5,4 %			41	2,1 %	1 753	92,4 %	1 896
1940	170	12,3 %			29	2,1 %	1 182	85,6 %	1 381
1945	382	14,7 %			56	2,2 %	2 159	83,1 %	2 597
1950	465	14,9 %			84	2,7 %	2 567	82,4 %	3 115
1955	978	18,2 %			131	2,4 %	4 269	79,4 %	5 379
1960	1 387	17,4 %	485	6,1 %	415	5,2 %	6 183	77,4 %	7 986
1965	2 378	18,5 %	860	6,7 %	681	5,3 %	9 829	76,3 %	12 888
1970	3 306	16,3 %	1 482	7,3 %	1022	5,1 %	14 421	71,3 %	20 231
1975	5 958	22,1 %	2 380	8,8 %	1564	5,8 %	17 077	63,3 %	26 979
1980	8 646	23,0 %	3 463	9,2 %	2255	6,0 %	23 249	61,8 %	37 613
1985	17 815	36,4 %	4 982	10,2 %	3377	6,9 %	27 797	56,7 %	48 989
1990	15 599	26,2 %	6 864	11,5 %	3962	6,7 %	33 048	55,6 %	59 473
1995	17 046	25,9 %	7 508	11,4 %	4388	6,7 %	36 951	56,1 %	65 893
2000	18 955	24,9 %	8 967	11,8 %	4852	6,4 %	43 632	57,4 %	76 006
2004	21 227	25,3 %	10 238	12,2 %	5550	6,6 %	47 051	56,0 %	84 066

** Included in private consumption 1930-1955*

As can be seen from Table 12 the consumption of electricity increased in all customer segments. The share of manufacturing industries – and forest industry in particular – has been substantial throughout the history of the electric power industry in Finland. The share of private customers and services has increase most from the 1970s onwards. One of the key reasons for the growth of the private electricity usage was the increased consumption of electricity heating in houses (see Figure 17) and the overall economical growth Finland.

There was a lively debate in the country regarding the benefits of private household heating methods at the end of the 1960s and in the 1970s. The Oil Crisis and the overall increase of oil prices accelerated the use of electricity for heating in private households in the 1970s. This process continued during the rest of the 20th century.

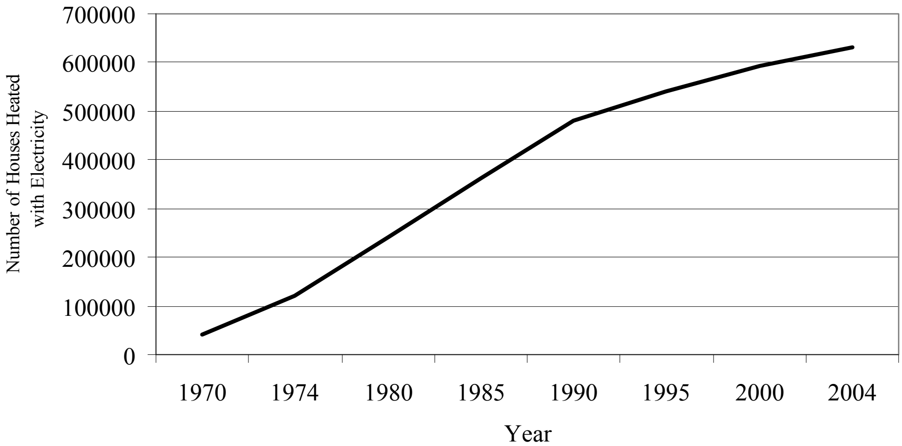


Figure 17: Number of houses heated with electricity in 1969-1974. Source: Finnish electricity statistics 1969-2004.

The nature of electricity as a commodity is that it cannot be stored for further use. Thus production capacity has to satisfy immediate consumption demands. Moreover, an extensive electricity transmission and distribution network is a key prerequisite of an efficient utilization of the available capacity within an area or a country. Thus the constant increase in demand in Finland created a continuous need for both new production capacity and for extending the electricity distribution network. In an open market, where technology is freely available for all actors, legislation does not restrict pricing, and raw materials are freely available, it is safe to invest in new production capacity and competition will take care of the prices. On the other hand, the available production capacity can restrict the supply and use of electricity and decreased demand can lead to overcapacity and thus underutilization of investments and consequently to decreased financial returns of these investments. However, in the Finnish electric power industry both the availability of technology and the electricity market itself was highly affected by the surrounding institutions. Therefore the evolution of power generation technologies and their availability to different kinds of firms, and the impact of legislation and regulation have to be further understood in order to be able to explain the sources of profitability and causes of survival of the different types of firm in the market.

6.3.2. Evolution of power generation technology

There are five supply factors of electricity production; labor force, primary energy resources, prime movers and electrical equipment, financial resources, and the institutional framework (Myllyntaus, 1991). The country of Finland mainly only possesses three indigenous primary energy sources; firewood, peat and hydropower. The principle energy source in Finland before electricity was firewood. It made up about 90 percent of the total energy supply in Finland by the First World War. Energy was firstly used for space heating and cooling (Myllyntaus, 1991). The total electricity consumption and the amounts of firewood felling are presented in Figure 18 and Figure 19.

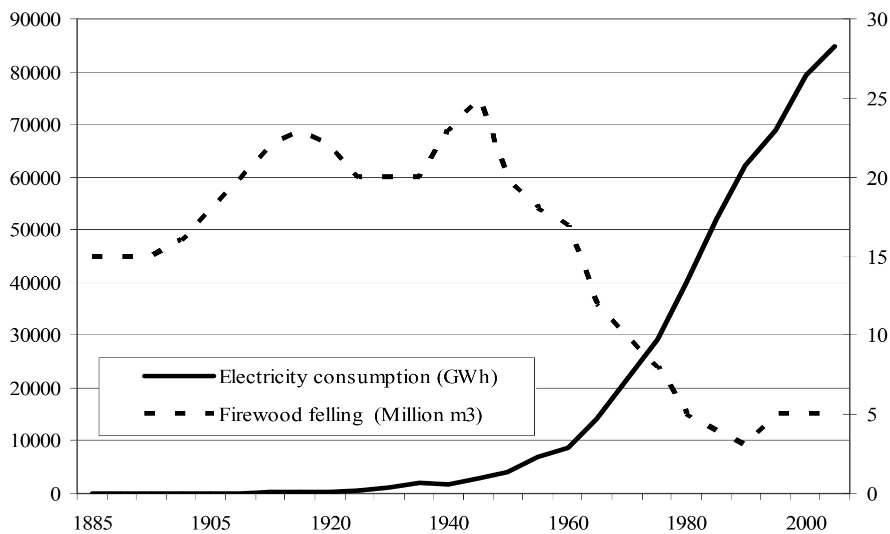


Figure 18: Electricity consumption (GWh, left axis), firewood felling (m3, right axis) Source: Statistics Finland.

Figure 18 shows clearly how electricity replaced firewood as a primary energy source. The use of fossil fuels, mainly coal and oil, increased at the same time as the electricity consumption, both as a source for producing electricity and for direct use, for example in traffic and transportation.

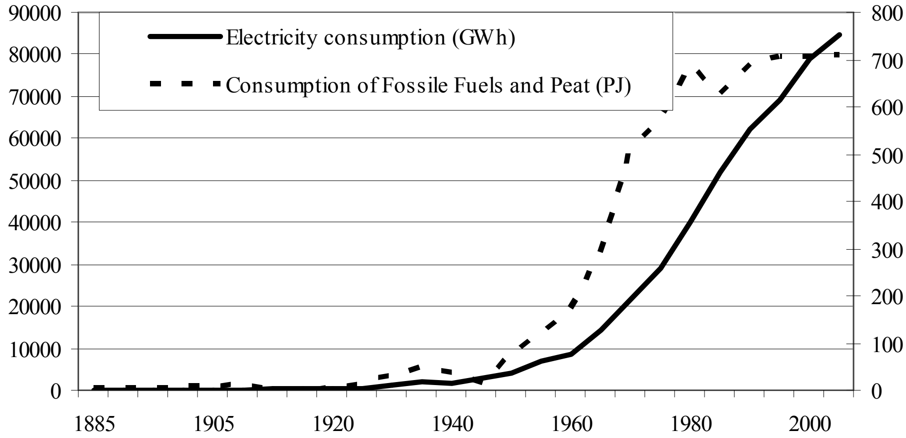


Figure 19: Electricity consumption (GWh, left axis) and consumption of fossil fuels and peat (PJ, right axis) during 1885-2005. Source: Statistics Finland.

Most of the first power plants used *thermal technology* for electric power generation. More specifically, thermal power generation started with *condensing technology* using coal and oil as primarily energy sources. Later, *back-pressure technology* was introduced by forest and other manufacturing industries to co-generate heat and power. Moreover, the forest industry started to use their wood refuse as a source of energy in these power plants. From the 1960s onwards central heating started to diffuse as a form of heating in houses and flats in urban areas. The *co-generation technology* of heat and electricity soon created a basis for vertical integration for urban distribution electricity firms, which provided both central heating and electricity for their urban end consumers. The synergy of combined heat and electricity production also kept the price of electricity down for the urban area consumers.

However, as more rivers were harnessed for electricity production, *Hydropower technology* gradually increased its share over thermal technology at the beginning of the 20th century. The key milestone in the increase of the share of hydropower technology was the decision in 1921 to build a hydropower plant on the river Vuoksi in Imatra. This more than doubled the existing production capacity of hydropower in Finland. The government continued to build hydropower plants on the main rivers in the country. Consequently, more than half of the electricity in the country was produced with hydropower by the beginning of the 1970s. Hydropower technology itself was not proprietary, but its utilization was. The utilization of hydropower was both directly regulated and impacted through water rights and the associated rights to build hydropower plants to the rivers. Moreover, although the investment and maintenance of hydropower plants were substantial, the source of energy – the flow of water – was free of charge. This, together with the rising costs of the raw material of the thermal power plants made hydropower technology financially superior over thermal power. For this reason the firms possessing hydropower assets – mostly owned by the government –had a significant financial advantage over the traditional thermal power generation firms. The co-generation of heat and power with back-pressure technology in forest and other industries was an exception to this rule because of the specific benefits of an integrated production of heat and electricity. However, in spite of the financial superiority of hydropower, the legislation and the consequent proprietary nature of that technology caused the thermal technology to be used increasingly by new electricity firms that entered the industry. Consequently, the total share of thermal technology in the Finnish electric power industry in 1960 was 36 percent, with half of this produced in manufacturing industry firms power plants utilizing the co-generation thermal technology.

From the 1970s onwards, *nuclear power technology* was also utilized in Finland. After lively debates in the Finnish Parliament and a multi-phased, heavily politically slanted purchasing process, the first nuclear power plant was eventually built in Finland and brought into use in 1977 by the government owned company IVO. The second nuclear power plant was built by TVO and brought into use in 1978. Nuclear power rapidly became one of the major energy sources for Finland. After the nuclear power plant accident in Chernobyl, in Ukraine in 1986, the nuclear power plant building projects were frozen in nearly all parts of the world. The Parliament of Finland voted against a fifth nuclear power plant in 1993, but later decided in 2002 to give a license for a fifth nuclear power plant; the building of that plant commenced in 2003.

There were two prerequisites that were needed in order to be able to utilize nuclear power technology in Finland. First, building a nuclear power plant needed substantial investment – even compared to other technologies such as thermal and hydropower which requires substantial investment the nuclear option is a considerably larger venture. Second, licensing of nuclear technology needed wide institutional support from the Government and from the Parliament of Finland. Both IVO and TVO possessed these capabilities and thus it was natural that they were the firms that were selected to build nuclear power in Finland. The share of different energy sources in power generation in Finland in years 1960 and 2005 is illustrated in Figure 20.

Figure 20: Sources of power generation by technology or other source. Source: Finnish electricity statistics 1960, 2005.

A noteworthy issue that needs to be considered when examining these statistics is that in addition to the power generated indigenously in Finland, in 2005 about 25 percent of electricity consumed in the country was imported from Sweden, Norway and Russia. The different power generation technologies are summarized in Table

13. The four main technologies have been included in the analysis. The analysis shows that three kinds of firms had a technological advantage in the industry.

Table 13: Comparison of the different power generation technologies in the Finnish electric power industry 1889-2005

Technology	Thermal power	Co-generation of heat and electricity	Hydropower	Nuclear power
Raw material	Firewood, peat, oil, coal	Firewood, peat, oil, coal	Water flow	Uranium
Level of proprietary	Low	Medium (only applicable when producing heat)	Medium-High (water rights)	High (licensing)
Investment costs	Low-Medium	Low (auxiliary costs to heat production)	Low-Medium	Very high
Impact of raw material price	High	Medium	Very low	Low
Business model with advantage		Industry specific firms, urban distribution firms with heat production	Government owned firms	Government owned firms

First, the *government owned electricity firms* had an advantage over the others for three main reasons: (1) they had property rights for the hydropower technology through the ownership of the water rights in the main rivers of Finland, (2) they possessed the financial strength to invest first in major hydro power plants and later in nuclear power plants and this was backed by the government, and (3) they had the institutional support for the licensing of both hydro power and nuclear power technologies

The second type of firm that had a technological advantage in the industry was the *industry specific firms* –particularly forest industry firms. – These firms possessed an advantage because they had (1) financial strength supported by the owner firms, (2) the ability to utilize the co-generation of heat and electricity technology in their plants, and (3) the secondary political support of the government. The third explanation for a technological advantage was that *urban distribution firms*, which provided central heating for the city's end users, could benefit from utilizing the co-generation of heat and electricity technology to produce electricity with marginal costs in addition to the heat production.

6.4. Evolution of business models

A study of the firms in the electric power industry in Finland at the end of the observation period, 2005, raises a typical evolutionary question: why are there so many and so distinct firms in the industry? In addition, when looking retrospectively from the year 2005 backwards to 1889, the next question that comes to mind is: what other kinds of firm have we had in the industry and why do they no longer exist? In the following chapters, the distinct business models of the industry and their characteristics are elaborated. In the final section the key selection criteria are summarized.

6.4.1. Emergence of distinct business models

As has been previously stated the first use of electricity in Finland was for electric lightning in cities and in industrial factories such as flour mills and timber mills. Even in the mills the first usage of electricity was solely for lightning purposes. The first power firms, some of which were private enterprises, and some public utilities, were established from the 1880s onwards for different purposes such as lightning in cities and factories and increasingly for manufacturing purposes and employed electric motors as source of power (Jaakkola, 1982; Myllyntaus, 1991). Common for these first firms was that they covered the whole value chain: from electricity generation, distribution[48] to retail or sales[49].

[48] At this stage there was no difference between transmission and distribution. I am therefore using distribution to cover both of these two components in the value chain, as distribution is the part of the value chain that connects the end user to the source of power.

[49] In these cases, when the owner of the electricity firm was directly using the electricity for its own purposes, the sales part of the value chain in practice did not exist because the internal sales was not counted in all cases.

Diversification of the electricity business had already started on a small scale at the beginning of the 1900s. The diversification can be seen from the perspective of firms that specialized in power generation for industrial usage, as well as from local firms that concentrated on power distribution and sales of electricity to end consumers. However, despite the primary reasons for establishing an electric power firm, most electricity firms were, until the 1960s, local utilities, which fulfilled all the power needs in their region - from industrial customers to agriculture end consumers. They also performed all functions of the electric power value chain from power generation to retail. Accordingly, a firm, which had a power plant which was primarily to serve a nearby industrial plant also distributed and sold electricity to the surrounding population. This point is also observable from the official industry statistics. Only from 1970 onwards did The Finnish Electricity Association and the Electrical Inspectorate of Finland[50] start to classify electricity firms and utilities in their statistics to the following categories: urban distribution, rural distribution, power generation, forest industry utility, and other industry utility.

The diversification of the value chain together with different ownership structures created different kind of firm segments in the Finnish electric power industry. These segments all have distinct business models. The data shows also that the evolution of these different segments varies significantly. Moreover, government legislation and rules, such as the impact of regulation and deregulation, has been different in the different firm segments. The segments of the Finnish electric power industry, their short history and status at the end of the research period, the year 2005, are described in detail in the forthcoming sections. A summary of the segments is presented in Table 14.

[50] According to the Electricity Law (1928), the electricity firms were obliged to provide statistics of their operations. The Electrical Inspectorate of Finland and its ancestors were given the responsibility of producing electricity statistics based on this information given by the firms.

Table 14: Electric power industry firm segments

Firm Segment	Major Activities	Sub Segment	Customers	Examples
Distribution	Building and maintaining of regional electricity network and physical distribution and sales* of electricity in the network area and connection of customers to the network.	**Urban distribution**	All customers connected to the network area in urban or city areas. Typically over 15.000 customers	Helsingin Energia Tampereen kaupungin sähkölaitos
		Rural distribution	All customers connected to the network area in rural area. Typically below 15.000 customers.	Vattenfall Verkko Oy Joroisten Energialaitos Kymenlaakson Sähkö Oy
Power Generation	Power generation and sale of Electricity.	**Power Generation**	Distribution firms, industrial firms, and NordPool electricity exchange.	Fortum Power and Heat Oy / Generation Teollisuuden Voima Oy PVO Lämpövoima Oy
Power Transmission	Nationwide power transmission (over 110 kV lines)	**Power Transmission**	All firms connected to the national grid such as power producers and regional distribution firms.	Fingrid Oy
Industry Specific Electricity Firm	Power generation and/or purchasing of electricity.	**Forest Industry**	Typically the owner industry firm. Some also sell to other customers or to the electricity exchange.	UPM-Kymmene Kaipola Stora Enso Kaukopää M-real Oyj Kirkniemi
		Other Manufacturing	Typically the owner industry firm. Some also sell to other customers or to the electricity exchange.	Neste Oil Porvoo Kemira Oyj Oulu Valio Oy
		Other Industry	Typically the owner industry firm. Some also sell to other customers or to the electricity exchange.	Finnair Oy Hki-Vantaa-Lento Ratahallintokeskus Sähköradat
Electricity Sales* **	Sale of electricity	**Electricity Retail**	Private and business end consumers.	Fortum Markets Oy Helsingin Energia Oy Vattenfall Sähkönmyynti Oy
		Electricity Trading	Wholesale customers.	Fortum Power and Heat Oy / Portfolio Management and Trading. Energiakolmio Oy.

** until the deregulation, 1995-1998*
***after the deregulation and establishment of the electricity exchange*
**** after the deregulation, 1995-1998*

6.4.2. Electricity distribution

The first electric public utility started in City of Tampere on November 15th, 1888, when the production dynamos, thirty lamps and the required equipment were purchased thus providing lightened streets in the City of Tampere for the first time (Jaakkola, 1982)[51]. The electricity operations of the City of Tampere were transferred in 1890 to a newly established electricity firm, O.Y. Sähkö. The next urban electricity firm, established as a public utility, was set up in City of Oulu in 1890. Other major cities, Helsinki, Viipuri, Vaasa, Kuopio, Turku, Joensuu and Pori all got their own electric firms by the end of the 1800s.

At first some of these were privately own firms, but very soon all the major cities established their own electric utilities or firms (Jaakkola, 1982; Myllyntaus, 1991). The municipal electric power firms started their business as providers of electric lightning for the streets of the city but soon expanded their business to sell electricity to private consumers (Jaakkola, 1982; Kunnas, 1984). This built the basis for the *distribution firms*, which at the beginning were situated in urban areas thus forming the basis for *urban distribution firms*. The electrification of rural areas evolved at a slower pace than in urban areas. It started with the expansion of the networks in the cities to the close-by villages. Moreover, these villages, which had some production plant such as a mill, a dairy or a factory, that produced electricity for their own purposes, usually started to obtain electricity from these factories.

The first *urban distribution firm* was Tyrvään Sähkölaitos, which was established in the year 1908. Although the number of firm exits were the highest among the rural distribution firms, some of the very first of them, such as Joroisten kunnan sähkölaitos, established in the 1910s, still existed in 2005, the end of the period of research. The key challenges in the rural areas were the long distribution distances and the relatively low number of consumers compared to urban areas. From the

[51] An interesting note is that Finland was at the forefront of municipal electrical provision in Europe; only two other utilities (Harnösand, 1985 and Växjö, 1987 in Sweden) were established before the electric utility in Tampere.

beginning of their existence these challenges caused financial strains to the rural distribution firms. The support from the municipalities and from government to the urban distribution firms was relatively low before the Second World War compared to the time after that conflict (Pylkkänen, 1982). Even if government supported countryside electrification after the Second World War, the support was relatively modest compared the costs (Turunen, 1992). As a consequence, numerous more or less official local electricity co-operatives emerged in the country. The smallest of these distribution co-operatives were delivering electricity for just a few end consumers. For example, in south-western Finland there were around 1000 small co-operatives (Haikala, 1987:35). This kind of distribution of work, in which the low voltage electricity distribution was taken care of by the small co-operatives and the distribution between the high voltage 110 kV network and the low voltage network was carried out by electricity distribution firm was typical in many parts of the country (Haikala, 1987; Turunen, 1992).

Only the largest of the electricity distribution co-operatives are included in the Finnish electricity statistics. The pace of mergers among these small co-operatives was even faster than among the larger urban distribution firms and this started to increase at the beginning of the 1960s. For example, there were 32 mergers between the co-operatives connected to Jyllinkosken Sähkö, a rural electricity firm in the west cost of Finland, in the period 1961-1962 (Turunen, 1992). During 1963-1969 Jyllinkosken Sähkö acquired 55 co-operatives. The key rationale for the mergers was the financial challenges faced by the smaller co-operatives and firms (Haikala, 1987; Turunen, 1992).

Both urban and rural distribution firms have the same responsibilities. The distribution network operator had an obligation to maintain and develop the distribution network below 110 kV, to connect electricity consumption sites and power generating installations to its network, and to transmit electricity between them. In addition, the distribution network operator was responsible for the condition of the network and the quality of the electricity supplied to consumers. Rural and urban distribution firms acted as local monopolies in their areas of responsibility. Until deregulation in 1995 they also held the monopoly to sell electricity in their network area. After deregulation they were required to open their network to other electricity sales firms. When it comes to the size of the firms, the electricity statistics did not differentiate between the size of customer base of the urban and the rural distribution firms. This is because the density of the distribution network was a more important factor when dividing the firms between these two segments. However, in general, the size of a rural distribution firm was below 15.000 customers, whereas the size of an urban distribution firm was typically over 15.000 customers.

Table 15: Largest regional distribution firms by number of customers connected to the network, year 2005. Source: Finnish electricity statistics 2005.

Firm Name	Number of Customers 2005
Fortum Sähkönsiirto Oy	410 681
Vattenfall Verkko Oy	369 664
Helsingin Energia	327 922
E.ON Finland Oyj	161 533
Tampereen Sähköverkko Oy	122 070
Savon Voima Oyj	104 666
Kymenlaakson Sähkö Oy	97 021
Järvi-Suomen Energia Oy	93 236
Vantaan Energia Oy	90 961
Pohjois-Karjalan Sähkö Oy	83 239

After deregulation the electricity distribution business was still strongly regulated. According to the Electricity Market Act the electricity network operation required a network license that was issued by the Energy Market Authority. The network license granted to a distribution network operator specifies the license holders' geographical area of responsibility and provides the distribution operator a local monopoly and the exclusive right to construct distribution networks. The largest regional distribution firms, by numbers of connected customers to the network, in 2005 are presented in Table 15. The three large incumbents from Finland, Sweden and Germany are on the list of the four largest distribution firms together with the distribution firm of the City of Helsinki, which is by far the largest city in Finland. It is notable that although there were over 100 distribution firms in Finland in 2000, the ten largest distribution firms covered more than half of the geographical area of the country and nearly half of the population.

6.4.3. Power generation

The first electric power firms had a variety of responsibilities covering the whole electricity value chain from generation to sales. Gradually, some of the firms specialized in power generation and sold their production of electricity either directly to large industrial customers or to the regional distribution firms. In 2005 there were about 120 firms engaged in electricity generation and about 550 power plants in Finland. However, although there were many such firms generating electricity, the volumes were concentrated mainly in two groups. Fortum Group accounted for 40 percent and Pohjolan Voima Group for 25 percent of Finland's electricity generation. In addition, electricity retailers and energy intensive industries such as the forest industry and metals industry were significant electricity generators. The largest electricity generators are presented in Table 16.

Table 16: Largest electricity generation firms by electricity production in TWh, year 2005. Source: Finnish electricity statistics 2005.

Firm Name	Electricity Production, TWh	Share of Total Production
Fortum Power and Heat Oy	21,4	27 %
Teollisuuden Voima Oy	14,1	18 %
Helsingin Energia	6,4	8 %
Kemijoki Oy	4,1	5 %
PVO-Lämpövoima Oy	2,8	3 %
Vaskiluodon Voima Oy	2,5	3 %
Tampereen Sähkölaitos	1,9	2 %
PVO-Vesivoima Oy	1,8	2 %
Alholmens Kraft Oy Ab	1,7	2 %
Oulun Energia	1,4	2 %

6.4.4. Power transmission

The network of long distance transmission lines started to increase from 1920s onwards. Originally, they were built by the power firms without any overall national plan. From the 1940s onwards there were two separate long distance transmission systems, the private and government owned grids. The private transmission system jointly owned by forest industry firms and private power generation firms eventually evolved into a single firm, Teollisuuden Voimansiirto Oy. The government owned system, on the other hand, was owned by IVO and evolved into the firm, IVO Voimansiirto Oy. These two firms merged in 1996 to form Finnish Power Grid Plc - Fingrid which is responsible for high voltage power transmission on the national grid. In addition to the grid comprising of the 400 kV, 220 kV and 110 kV power lines, the company owns also cross-border lines between Finland and Sweden, Finland and Norway and Finland and Russia. Fingrid's owners are Fortum and PVO, each of which owns about a quarter of the shares of the company, the State of Finland which own about one eighth of the shares, as well as some institutional investors. In 2005, in addition to the national grid, there were 13 regional high voltage (mostly 110 kV) firms operating the regional grids – the grid between the national grid and regional distribution networks.

6.4.5. Industry specific power firms

The industry specific power firms have their origins in the factories, which required electricity, first for lightning and then for the efficiencies of production. The printing industry was the pioneer in using electricity as a power source. By 1920 virtually the whole printing industry had undergone electrification. Other manufacturing industries followed stepwise after that so that by 1960, about 97 percent of mechanical drives used electricity in the manufacturing industry (Myllyntaus, 1994). The need for electricity in manufacturing processes created a special group of electricity firms, whose task was either to generate or to purchase and generate electricity for a specific factory or a collection of factories. At the beginning these firms also acted as power generators and regional distributors of electricity to the nearby villages. Gradually they specialized in serving their dedicated industry and sold excess capacity, when available, directly to distribution firms, other enterprises or after the deregulation to the Nordic Electricity Exchange, Nord Pool.

The manufacturing industries share of the total electricity consumption in Finland has been significant throughout the period of evaluation: it was over 80 percent until the year 1950 and was still at 56 percent in 2004. In Finland, the forest industry firms constitute a noteworthy branch among the manufacturing firms. The forest industry factories, especially the pulp grinding mills needed a substantial amount of heat and steam in their manufacturing processes. For this purpose the Finnish pulp and paper firms were at the forefront of developing and utilizing back-pressure power plants which co-generated heat (steam) and electricity (Haavisto, 1982). All in all the share of the electric power firms specializing in providing power for forest industry has been notable in the Finnish electric power industry throughout the period of evaluation, both in terms of electricity volumes (GWh) and number of firms in the industry. This is depicted in Figure 21.

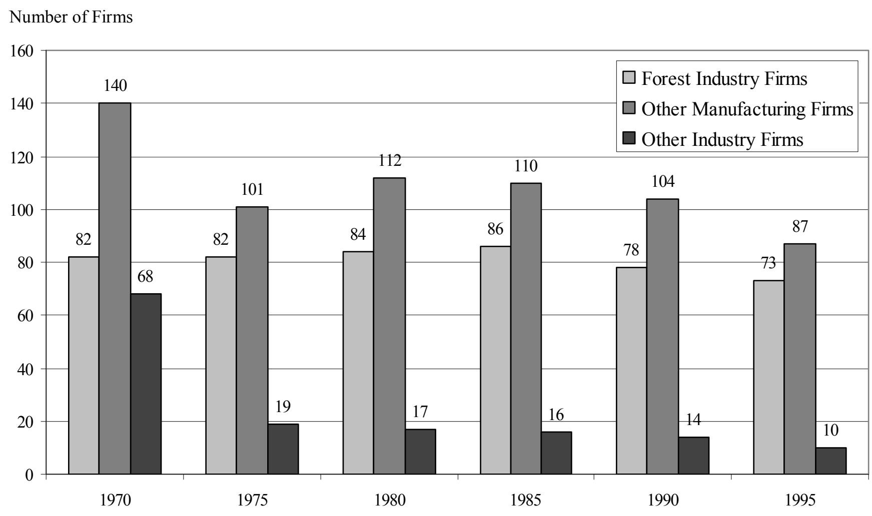


Figure 21: Number of industry specific firms in 1970-1995. Source: Finnish electricity statistics 1970-1995.

Indeed, the coevolutionary relationship between the electric power industry and the forest industry was similar to clusters in the telecommunications industry in Finland and Sweden (see Berggren and Laestadius, 2003[52]).

6.4.6. Electricity sales and trading

Prior to deregulation the sale of electricity was conducted widely by both the power generators and the distribution firms. The Electricity Market Act only actually liberated electricity sales. In practice the distribution firms could continue to sell electricity if they fulfilled the unbundling criteria of the law. In the act unbundling means that an income statement and a balance sheet from the electricity sales or trade operations shall be unbundled from the grid operations and distribution system operations for each financial period. In practice this led to the largest retailers such as Fortum (formerly IVO) and Vattenfall to set up new retail sales firms, whereas the smaller retailers kept the sales and distribution businesses in the same physical firm but merely fulfilled the unbundling criteria in their financial statements. However, the notable difference for the regional distribution firms was that they lost their regional exclusive right to sell electricity.

According to the Electricity Market Act electricity sales does not require a license; anyone can become an electricity retailer. Electricity retail was in 2005 mainly carried out by local supply firms. They sell electricity that they have generated or purchased from the wholesale market. After the Nordic power exchange Nord Pool was fully set up, most of the wholesale market moved there. In addition, the largest energy producers continued to sell electricity by direct contract to the large industrial customers. Moreover, a number of electricity retailers and dealers that are independent of the traditional electricity firms have emerged in the electricity sector

[52] Berggren and Laestadius (2003) studied the clusters in telecommunications in Finland and Sweden in the 20th century. They showed how the clusters developed under various regulatory regimes in a complex industrial history and led to competitive public–private development pairs both in Finland and in Sweden and this led to accelerated industry growth in the 1990s.

since deregulation. The summary of the largest electricity sales firms in Finland by turnover in the year 2005 is presented in Table 17. It is notable that the four largest firms (when combining the first two Fortum owned firms) are the same four which are the largest electricity distributors. The major reason for this is the low rate of end consumers that have changed their electricity supplier after the market opening - only 11 percent during the years 1996-2004.

Table 17: Largest electricity sales firms by turnover in 2005. Source: Finnish electricity statistics 2005.

Firm Name	Turnover, Million Euros, 2005
Fortum Power and Heat Oy	828
Fortum Markets Oy	672
Helsingin Energia	257
Vattenfall Sähkönmyynti Oy	147
E.ON Finland Oyj	90
Energiapolar Oy	81
Savon Voima Myynti Oy	70
Oulun Energia/Sähkön siirto ja jakelu	69
Vantaan Energia Oy	64
Tampereen Sähkölaitos	63

After deregulation, in August 1995, a Finnish electricity exchange EL-EX started its operation. Power trading, as a Nordic operation, had been extended into Finland when a new actor in the Nordic electricity market, Nord Pool, the Nordic Power Exchange, started its operation in Finland in June 1998. Nord Pool increased the number of sources of electricity supply for large scale users and retailers. Only members of the Nord Pool could trade in electricity at the power exchange. Among the members of the power exchange are power generation and other electricity firms and industrial firms from Finland, Sweden, Norway and Denmark as well as some other countries. The power exchange formed a market price for electricity, which was used as a reference price while drawing up electricity sales contracts.

6.4.7. Vertical integration as an opposite trend to diversification

In addition to the diversification of the value chain, a notable phenomenon in the industry has been vertical integration. Three distinct business models, all vertically integrated can be found in the industry. The first group consists of the industry specific electricity firms, responsible for power generation and supply to their industry, typically to their owner firm. Following the transaction cost economics logic, as a competitive wholesale market did not exist, it was more profitable and secure to produce the electricity in-house. Moreover, in many cases the connection to the value chain of the particular industry was closer and more secure than the connection to the value chain of the electric power industry. An extreme example of this was the forest industry, where the back-pressure technology enabled the residual heat of the steam produced in a steam power plant for the pulp process to be utilized for central heating or turned to electricity. The second group, the distribution firms, had typically kept their power generation plants and operations, even if their major operations covered the distribution networks. According to the electricity laws prior to deregulation in 1995, the regional distribution firms also had the exclusive right to sell electricity to customers connected to their network. Moreover, in urban areas were the firm also provided central heating, back-pressure technology enabled combined heat and power generation thus providing additional electricity generation capacity at practically the expense of producing central heating.

With regard to the third business model, there was a clearly identifiable trend in Europe in the 1990s that the originally government owned incumbents, and often monopolies in their respective countries such as Vattenfall in Sweden, E.ON in Germany, and EDF in France, utilized their position to enter other counties electric power markets after deregulation. This also happened in Finland. After deregulation the large government owned firm IVO, which prior to deregulation was responsible for the national transmission operations and the majority of the power generation in Finland, started to acquire electricity distribution firms. IVO (later Fortum) built the basis for its electric distribution and retail operation in Finland by acquiring Länsivoima Oy (formed from Lounais-Suomen Sähkö Oy) in 1996, finally merging it into the mother company during 2000. Another key acquisition in southern

Finland, Elnova Oy, was merged into Fortum during 2003. Moreover, during the late 1990s IVO had already entered the Swedish electricity power market by acquiring 50 percent of the second largest Swedish electric power firm, Birka Energi. Fortum acquired full ownership of the firm in 2001 and merged with it thus building the basis for Fortum's Swedish operations.

In addition, two international firms – Vattenfall and E.ON – which had similar vertically integrated business model to IVO (Fortum), entered the Finnish electricity industry in the 1990s and in the beginning of the 2000s. Vattenfall, a limited company since 1992, but owned 100 percent by the Swedish government, was a market leader in Sweden and started its international expansion in the 1990s, with acquisitions of Finnish electricity firms. Lapuan Sähkö and Hämeen Sähkö were acquired in 1995, Heinola Energia and Revon Sähkö in 1999, and Keski-Suomen Valo and Hämeenlinnan Energia in 2000. Vattenfall has also heavily extended its operations towards central Europe during the late 1990s and early 2000s, and acquired firms in Germany, mainly from the former East Germany, and in Poland. E.ON, one of the largest power firms in Europe, was formed in 2000 via the merger of VEBA and VIAG, two of Germany's largest, and originally government-owned, industrial groups. E.ON started its international expansion during the 2000s. It made significant acquisitions in Europe and also expanded to the Nordic area: it acquired Sydkraft, the third largest power firm in Sweden, during 2001and entered Finland in 2001 by acquiring the majority of Espoon Sähkö.

To summarize, the analysis of the business model evolution shows that the business model of a firm, is a result of both (1) evolutionary and (2) causal mechanisms. The underlying change was evolutionary and the creation of the distinct business models was emergent and driven by the market and the customer needs. The 'natural' value chain diversification and the vertical integration on the other hand are good examples of two these kind of change processes. Furthermore, there were clearly identifiable causal impacts of the regulation on the evolution of business models. For example, the electricity and electricity trading business models were created as a result of deregulation- the Electricity Market Act. Thus there was a coercive causal mechanism behind this change.

6.5. Selection criteria

6.5.1. Impact of size on firm survival

Based on the existing scholarly literature, firm size and age are considered to be the key selection criteria that define firm survival. There are two key measures of firm size in the electric power industry. The first is the number of customers; the second is the total supply of electricity, measured in MWh. The latter is comparable to the total turnover of the firm and is therefore used in the analysis as the primary measure of firm size. The two measures also reflect the area of value chain specialization of the firm. The number of customers is high in electricity distribution and retail firms, whereas the supply of electricity is typically high in the power generation firms. A summary of the analysis of the top ten firms at turn of the periods, in the years 1940, 1970 and 1995[53], is presented in Table 18. The analysis shows an interesting phenomenon during the life course of the industry: most of the ten largest firms remained among the top ten either directly or as firms merged with other firms. This reflects the asset cumulation and asset mass efficiencies of the industry. In the industry, seven firms out of the top ten in 1940 were still, either directly or as merged with other firms, among the top ten in 1995.

Moreover, all of the top ten firms in 1970 were also still among the top ten, either directly or as merged with other firms, in 1995. A notable observation from a comparison of the ten largest electric power firms and the largest industrial firms in Finland in Hjerppe's (1979) basic statistics is that five out of the largest electric power firms in 1940, in terms of gross value of production, were already among the ten largest firms in Finland in 1938. Again, five out of ten largest electric power firms in 1970 were among the eleven largest firms in Finland in 1975. Four out of these five were forest industry firms.

Table 18: Largest firms by total supply in 1940, 1970 and 1995. Source: Finnish

[53] These years were selected for the analysis as exact statistics were available from the years.

electricity statistics 1940-1995.

Rank 1940	***Rank 1995***	***Firm or utility***	***Total supply 1940, MWh***	***Major ownership***	***Ownership changes***
1	1	Imatran Voima Oy (IVO)	588,755	Government	
2	>50	Länsi-Suomen Voima Oy	148,612	Several	
3	2*	Etelä-Suomen Voima Oy	134,900	Forest industry	Merged to PVO
4	3*	Kymin Oy	112,955	Forest industry	Merged to UPM-Kymmene
5	4*	Tornator Oy	111,855	Forest industry	Merged to Enso-Gutzeit (StoraEnso)
6	N/A	Tampella Oy	106,469	Other industry	
7	10	Helsingin kaupungin sähkölaitos	103,351	Municipal	Former Helsingin Energia
8	2*	Nokia Oy	80,166	Other industry	Merged to PVO
9	N/A	Rosenlew & Co. Oy	64,973	Other industry	
10	1*	Abborfors Oy	47,179	Forest industry	Merged to IVO and 2000 to Helsingin Energia
Rank 1970	**Rank 1995**	**Firm or utility**	**Total supply 1970, MWh**	**Major ownership**	**Ownership changes**
1	1	Imatran Voima Oy	10,503,060	Government	
2	1*	Kemijoki Oy	2,200,689	Government	Merged to IVO
3	10	Helsingin kaupungin sähkölaitos	1,961,469	Municipal	Former Helsingin Energia
4	1*	Oulujoki Oy	1,952,444	Government	Merged to IVO
5	2	Pohjolan Voima Oy	1,657,032	Forest industry	
6	4	Enso-Gutzeit Oy	1,635,480	Forest industry	
7	5	Outokumpu Oy	1,489,317	Other industry	
8	2*	Etelä-Suomen Voima Oy	1,238,936	Forest industry	Merged to PVO
9	3*	Yhtyneet paperitehtaat Oy	1,079,732	Forest industry	Merged to UPM-Kymmene
10	3*	Kymin Oy	1,007,601	Forest industry	Merged to UPM-Kymmene
Rank 1995	**Rank 1995**	**Firm or utility**	**Total supply 1995, MWh**	**Major ownership**	**Ownership changes**
1	1	Imatran Voima Oy	31,341,690	Government	
2	2	Pohjolan Voima Oy	11,678,733	Forest industry	
3	3	UPM-Kymmene Oy	11,585,892	Forest industry	
4	4	Enso-Gutzeit Oy	8,088,730	Forest industry	
5	5	Outokumpu Oy	4,857,995	Other industry	
6	6	Kemijoki Oy	3,675,938	Government	Sold 1997 to IVO, UPM, StoraEnso and municipalities
7	7	Teollisuuden Voima Oy	3,674,966	Several	
8	8	Teollisuuden Voimansiirto Oy	3,308,200	Forest industry	
9	9	Länsivoima Oy	2,933,349	Municipal	Merged to Fortum(IVO) 2000
10	10	Helsingin Energia	1,588,918	Municipal	

**** after merger to another firm***

The analysis reveals three phenomena of the trajectories of the largest firms. First, the dominant owners in period after period were the government and forest industry. The only municipally owned firm in the top ten list during each period was that of Helsingin Energia - the Electric Utility of City of Helsinki, the capital of Finland- which by far had the largest customer base in the country in terms of number of end consumers. The second phenomenon, the mergers in the forest industry with a consolidation towards two dominant firms, UPM-Kymmene and StoraEnso, is also reflected in the list of the largest firms in the electric power industry, because the electricity firms owned by these firms were part of the overall mergers. Thus consolidation in the forest industry caused consolidation in the electric power industry[54]. The third phenomenon is that there was a trend of mergers among the largest firms towards the two dominant firms in the industry: the government owned IVO and the forest industry owned PVO. The analysis shows that those firms that survived the first period continued to be among the largest in one form or another when the last phase, that of deregulation, started. The largest firms remained large for period after period and survived the shakeout – or were to some extent causing the shakeout.

Furthermore, deregulation had no impact in the ownership of the largest producers or firms with the largest supply, although the consolidation trend continued. For example, during the 1990s, Länsirannikon Voima Oy and Etelä-Suomen Voima Oy were merged with PVO, which also acquired Oy Nokia Ab's energy business. Furthermore, Fortum acquired Stora Enso's power generation during 2000. The production market share of the three largest producers has been at over 50 percent both pre- and post-deregulation, between 1984 and 2004. This is depicted in Figure 22.

[54] Similarly, even if not reflected among the largest firms in the industry, the mergers of the municipalities caused mergers within the electric power industry as the firms in the industry owned by the municipalities were merged as part of the overall municipality mergers.

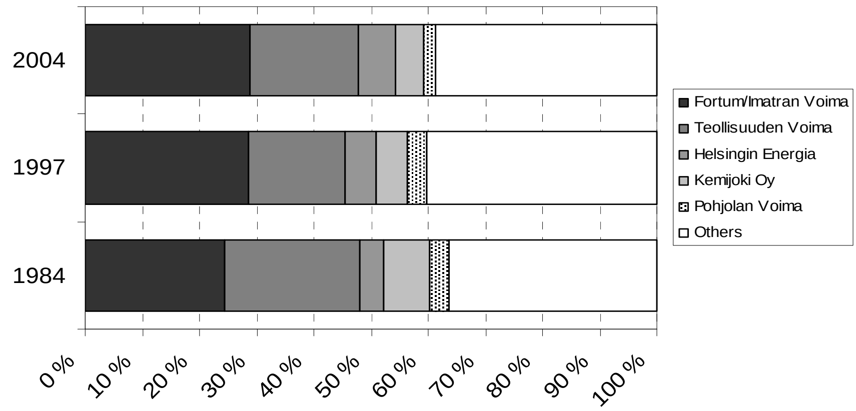


Figure 22: The Share of the Largest Producers: Source: Finnish electricity statistics 1984-2004.

Notwithstanding the above, the analysis of the largest firms in terms of number of customers shows that this list was dominated by municipally owned firms. This was a result of the early trends – and the subsequent path dependence – that the municipalities took care of power distribution for the end users within the boundaries of their municipality. Consequently, they established electric power firms specializing in power distribution, but which were often also vertically integrated or owned the close-by power generation plant that was connected to the distribution network. The electricity legislation or regulation supported this trend. For example, the government owned IVO was not permitted to provide electricity distribution services prior to deregulation. However, after deregulation, both the government majority owned Fortum (former IVO) and the international entrants, Vattenfall and E.ON entered the electricity market which concentrated on electricity sales and distribution to end customers. The change of the ownership after deregulation among the largest firms, listed by number of customers is presented in Table 19.

Table 19: The change of ownership of the five largest firms in 1995 by their number of customers: Source: Finnish electricity statistics 1995.

Rank 1995	*Firm or utility*	*Number of customers 1995*	*Major ownership prior to 1995*	*Ownership changes after deregulation*
1	Helsingin Energia	299,687	Municipal	No change
2	Hämeen Sähkö Oy	141,005	Municipal	Acquired by Vattenfall in 1995
3	Lounais-Suomen Sähkö Oy	135,243	Municipal	Acquired by IVO in 1996
4	Tampereen kaupungin sähkölaitos	112,650	Municipal	No change
5	Espoon Sähkö Oy	106,417	Municipal	Acquired by E.ON in 2001

6.5.2. Summary of selection criteria

A summary of the key selection criteria during the life course of the electric power industry in Finland is presented in Table 20. The results of the analysis support the view that size and technology were among the selection criteria that age by itself was not. However, in some cases age impacted positively on firm size -if the legislation of ownership did not restrict it. Generally, it was the right combination of size, technology and business model that most impacted individual firm survival. On the other hand, the business model had the greatest impact on firm survival, with significant differences between different business models.

Table 20: Impact of key selection criteria on distinct business model survival

Business Model	**Impact of Selection Criteria on Firm Survival (No impact = 0, Positive = +, Negative = –)**			
	Age	**Size**	**Technology**	**Vertical Integration**
Distribution	0	+	+/–	+
Power generation	0	+	+/–	0
Industry specific firm	0	0	0	0

For distribution firms, size, the right technology and vertical integration of distribution and generation impacted positively on firm survival. Equally, size and the right technology impacted positively on firm survival for power generation firms. However, none of the criteria had an impact on industry specific firm survival. The linkage of the owner/customer was so strong that it overruled the other criteria. Furthermore, it is notable that certain types of ownership structures dominated within the distinct business models: municipalities in distribution firms, government in power generation and industrial owners in the industry specific firms. Thus the ownership structures also impacted the survival of the firms.

6.6. *The two shakeout episodes*

Hitherto the analysis of data in the historical narrative analysis supported by evidence from the descriptive numerical analysis has highlighted the key events during the life course of the industry and pointed out the key selection criteria. Next, a descriptive numeric analysis of firm entries and exits is carried out in order to confirm the existence of the shakeouts periods. Thereafter the entries and exits by business model during the shakeouts are analyzed to identify the impact of the shakeout on distinct business models. Subsequently, a causal analysis is performed and causal diagrams are presented to explain the causal connections between the events and identify the key mechanisms by combining the historical narratives and descriptive numeric evidence.

6.6.1. Two shakeout episodes after year 1970

The analysis of the total number of firms, as depicted in Figure 23, shows that the number of firms increased from the beginning of the observation period, 1889, until 1970 except for two environmental shocks, the Great Depression and the Second World War. In 1970 the number of firms reached its peak; a total of 570 firms. Thereafter the number of firms started to decline. The analysis of firm exits from the industry during this *consolidation episode* between 1970 and 2005 shows that there were two *shakeout episodes*, when firm exit rates were significantly higher that during other periods.

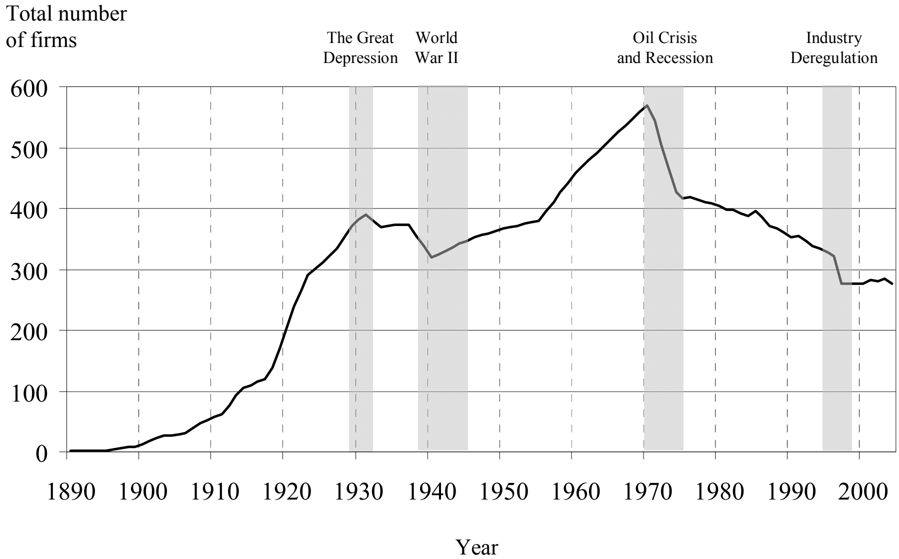


Figure 23: Total number of firm number change by year. Source: Finnish electricity statistics 1930-2005.

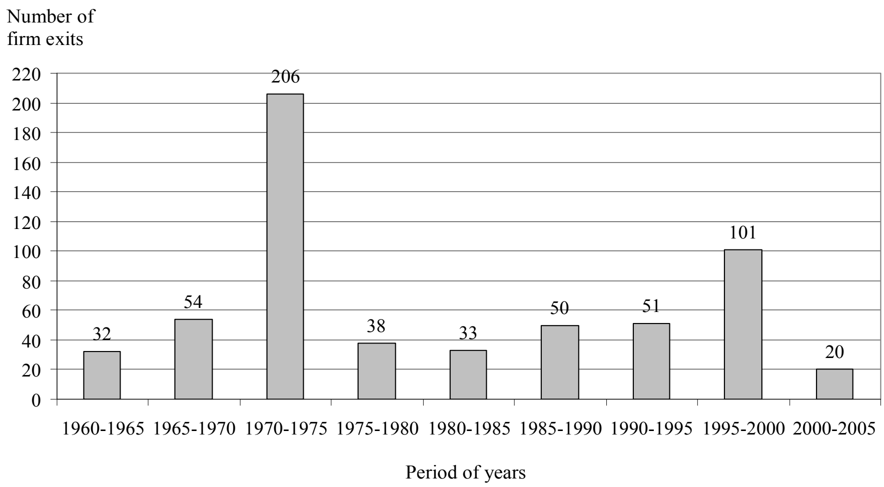


Figure 24: Total number of firm exits 1960-2005: Source: Finnish electricity statistics 1960-2005.

As, at the same time, there were a significant number of firm entries to the industry after the deregulation, altogether 67 entries between 1995 and 2005, the second shakeout episode is not reflected in the total number of firms that are depicted in Figure 23. However, a five-year period exit analysis, as depicted in Figure 24, shows that the first shakeout period was between 1970 and 1975 and the second between 1995 and 2000.

A deeper analysis of the firms that exited the industry highlights a key observation of the analysis: firm exits were not evenly distributed between the different business models during these shakeout episodes. Three types of electric power firms were particularly hit during the *first shakeout episode*. These are shown in Table 21.

Table 21: Exits and entries of different types of firms between 1970 and 1975. Source: Finnish electricity statistics 1070-1975.

Business Model	Number of Firms 1970	Number of Firms 1975	Difference (n)	Difference (%)	Exits	Entries
Urban distribution	63	60	-3	-5 %	-3	0
Rural distribution	180	123	-57	-32 %	-66	9
Power generation	37	32	-5	-14 %	-7	2
Forest industry power generation	82	82	0	0 %	-16	16
Other manufacturing power generation	140	101	-39	-28 %	-59	20
Other industry or public sector power	68	19	-49	-72 %	-55	6
Total	**570**	**417**	**-153**	**-27 %**	**-206**	**53**

First, there were total 66 exits from the segment of rural distribution firms causing one third of firms with that business model to disappear from the industry. Second, the segment consisting of other manufacturing power firms decreased by 59 firms. And finally, other industry or public sector firms decreased radically; there were 55 exits and the total number of firms decreased by 72 percent. Of all of the exits the highest proportion was of rural distribution firms which had already started in 1965 and continued until 1980. Between 1965 and 1970 there were total 31 rural distribution firm exits, which represents 57 percent of all the industry exits. Equally, there were 17 rural distribution firm exits between 1975 and 1980 representing 45 percent of all industry exits. For the other shakeout group, there were very few exits during the two five-year periods before and after the shakeout; only 17 altogether, which represented 18 percent of all exits during these two periods.

Equally interesting in terms of firm survival are those types of firms that were not impacted during this period. Compared to the rural distribution firms, which had a significant number of firm decrease, there were only three urban distribution firms that made an exit representing a five percent decrease in that group. In addition, the total number of forest industry electricity firms remained the same, even if there were structural changes within that group with 16 firm exits and the same number of firm entries[55].

During the *second shakeout episode*, which occurred after industry deregulation in 1995, the highest number and proportions of exits were within forest industry power firms and other manufacturing firm electricity firms. Half of the other manufacturing electricity firms – a total of 52 exits - were driven away from the industry. Also at this stage the total number of forest industry electricity firms decreased by 27 percent. Industry restructuring between electricity distribution, sales, and

[55] It is notable at this stage, that in the electricity statistics the firms have been coded with a special code. Therefore, firm name or ownership changes do not account as new firms of firm exits. Only totally new firm codes have been counted as firm entries. Likewise, only code exits have been counted as firm exits.

generation, can be seen in the number of firm entries. A summary of the firm entries and exits is depicted in detail in Table 22.

Table 22: Exits and entries of different types of firms between 1995 and 2000. Source: Finnish electricity statistics 1995-2005 and Adato Energia Oy.

Business Model	Number of Firms 1995	Number of Firms 2000	Difference (n)	Difference (%)	Exits	Entries
Urban distribution	46	42	-4	-9 %	-4	0
Rural distribution	69	64	-5	-7 %	-7	2
Power generation	43	56	13	30 %	-7	20
Forest industry power	73	53	-20	-27 %	-26	6
Other manufacturing power	87	37	-50	-57 %	-52	2
Other industry or public sector power	10	6	-4	-40 %	-5	1
Electricity sales	N/A	14	N/A	N/A	N/A	14
Regional network	N/A	10	N/A	N/A	N/A	10
Total	**328**	**282**	**-70**	**-21 %**	**-101**	**55**

In summary, the analysis of data on firm number evolution – entries and exits – has shown that there were two shakeout episodes in contrast to one shakeout during the industry life cycle, and the shakeouts affected the distinct types of electric power firms or business models in a different way. Thus, the business model of a firm acted as key selection criteria during the shakeouts.

6.6.2. Causal analysis of the first shakeout episode 1970-1975

The next research challenge was to discover *why* the industry faced these two shakeouts and what the environmental and intra-industry mechanisms behind the exits were. I therefore analyzed the key events, which led to firm mergers and acquisitions and consequently to firm number decreases in the industry in the 1970s, and their causal connections. In doing so I made use of causal diagrams.

There are three identifiable causal flows of events that led to the final shakeout. The first flow explains technological path dependence under institutional coercion and environmental shocks and elucidates a coevolutionary process; a macro-micro-macro feedback loop between the levels of analysis. The second clarifies the path dependence and institutional driving mechanisms. The third flow explains the ownership changes leading to firm exits.

The full causal diagram with the major events during the history of the electric power industry in Finland leading to the first shakeout episode is depicted in Figure 25. The events are presented at the three levels of analysis; the institutional level (including the events in the overall society as well as the legislative actions), the industry level and the level of the firms. The final events leading to the shakeout in the three causal flows is depicted in Figure 26. In the causal diagrams the boxes represent the empirically identifiable events during the history. The arrows represent the links between the events or the mechanisms. Thus the causal diagrams form the behavioral description of the mechanical model (Glennan, 2005); they are used to outline the overall phenomenon and to depict what the mechanisms are doing in the phenomenon. The mechanical description of "how the mechanisms do it" (Glennan, 2005) are developed through the detailed event analysis and summarized in Table 23 and Table 25. One of the key goals of the mechanical description is to explain and describe the key characteristics of the mechanisms.

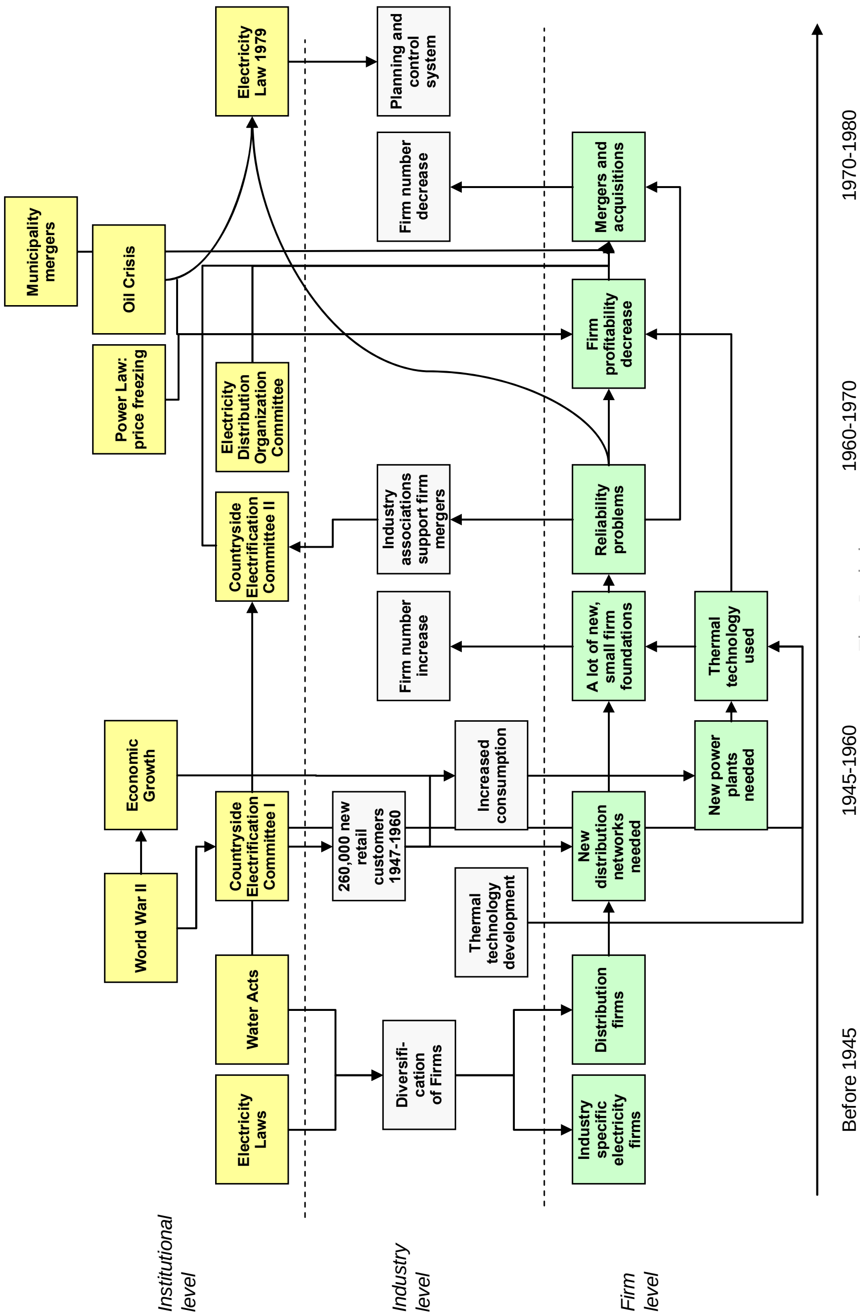


Figure 25: Event analysis leading to the first shakeout episode 1970-1975

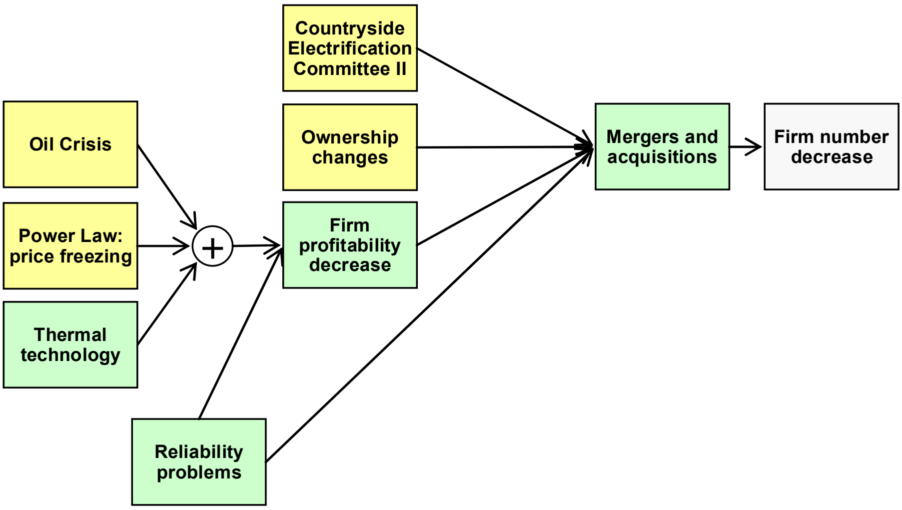


Figure 26: Final events and causal connections leading to the first shakeout

Causal flow 1.1. Technological path dependence under institutional coercion and environmental shocks

The first causal flow and set of events started at the beginning of the period of analysis. The legislation (Electricity Laws 1901[56] and 1928[57]) and the Water Act 1902[58] laid the basis for firm diversification. According to the electricity laws construction of a plant for the purpose of electricity production required a license. In case the plant was built on a river in order to utilize hydropower technology, another license was needed. The licensing directed the diversification of the firms; some concentrated on power production, others on electricity distribution. In addition, the Water Act 1902 made the exploitation of hydropower proprietary and in practice

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[56] 'Laki sähkölaitoksista valon synnyttämistä tahi voiman siirtoa varten, 1901'.
[57] 'Laki sähkölaitoksista, 167/1928'
[58] 'Vesilaki, 31/1902'

concentrated its ownership to the government who were the major riverside landowner in the country.

The number of firms in the electric power industry started to increase at the beginning of the 20th century with clear variation on distinct business models. Due to legislative events and their effects the variation among the population was, to a large extent, not only emergent and evolutionary, but also causal, directed and coerced by government through legislation.

It is notable, that one of the goals of the water acts was to limit the impacts of hydropower plants to other landowners and businesses, such as fishermen and farmers. However, this goal was considered not to be fulfilled effectively enough from the local business point of view and consequently opposition from local farmers and fisherman concerning the building of hydropower plants arose (Myllyntaus, 1991). Accordingly, the opposition acted as a mediating event to further accelerate the selection of technology in the industry (Tuuri, 1976).

A detailed analysis of the effects of the different water acts and the characteristics of the generative mechanisms is presented in Table 23. As mechanisms cannot be directly identified from the empirical data, one has to identify the events and the characteristics of the relationship of the events. In the case of the causal flow initiated by the legislative events at the beginning of the 20th century mechanisms initiated with a clear agency, the government can be identified. These mechanisms directed and coerced variation in the industry. Thus, they can be characterized as *causal and agency identifiable variation accelerating mechanisms*.

The causal chain initiated by the legislative events at the beginning of the 20th century, together with the overall technological development of thermal power technology and the pressure of increasing demand of electricity, led to a significant – and emergent – increase in thermal technology to a total 36 percent of the country's total production capacity in 1960.

Table 23: Analysis of the initial causes and effects within causal flow 1.1.

Causal events	**Water Act 1902[59] and its extensions in 1934, 1940, 1941 and 1957.** **Law of transmitting electricity over Finnish Borders 1919[60]** **Water Act 1961[61]**
Initial goal of the causal events	→ Ensure the rights to use water areas for public purposes and protection of water areas[59,61]. → Determine principles of construction in water areas[1,3]. → Define rights of hydroelectric power utilization for land owners[1]. → Make hydroelectric power utilization dependent on a license[1,3]. → Limit the impacts of hydropower plants to other landowners and businesses, such as fishermen and farmers[1]. → Restrict transmission of electricity over the Finnish borders[2].
Interest groups involved in preparation	Government as the major land owner. Land owners. Electricity firms.
Effects of the events and type of mechanism	→ Foreign ownership of Finnish rapids was transferred to the government (Karjalainen, 1989; Vehmas, 2002). [C,A,I] → Most of hydroelectric power generation was owned by the government. [D, A] → The Water Act (1901) was considered not to protect properly the local farmers' and fishermens' rights (Myllyntaus, 1991). Consequently opposition from local farmers and fisherman to build hydropower plants arose; "in construction of hydropower, it is more difficult to sole the issues of riparian rights and gain permits from the authorities than to master technology (Tuuri, 1976:100, 105-124)". [EV,EM, U] → Several distribution firms did not have the opportunity to utilize hydropower technology, and it was opposed by the local people, who in many cases represented the owners of the firms. On the other hand thermal technology was freely available. [EV, EM]
Characte-ristics of the generative mechanisms	[C] – coercive causal mechanism [D] – driving causal mechanism [EV] – evolutionary mechanism [EM] – emergent mechanism [A] – identified agency: in these cases government [I] – intentional: the initial goal of the agent became materialized [U] – unintentional secondary impact (due to combined impact of other parallel processes and mechanisms)

[59] 'Vesilaki, 31/1902'
[60] 'Laki sähkövoiman siirtämisestä maan rajojen ulkopuolelle, 19/1919'
[61] 'Vesilaki, 264/1961'

Thus, the environmental conditions created by the earlier mechanisms and the long lifetime investment nature of the industry caused a technological lock-in to thermal technology. Consequently, an *evolutionary mechanism* that caused path dependence for the selected technology in the industry can be identified. Moreover, this mechanism can be characterized as *emergent*, as there is no identifiable agency initiating the mechanism.

After the growth period during the first decades of the 20th century, the Second World War was an environmental shock not only to the electric power industry in Finland, but to society as a whole. The areas in the southeastern part of the country that were ceded to the Soviet Union in the truce agreement contained electric power firms and power plants operating in that area. Consequently, the number of firms in the industry decreased as a result of the truce agreement and the subsequent cession of territory. Thus, in this case the connection between the environmental shock and the structure of the industry and firm survival was directly causal. However, Finland was able to recover from the war with subsequent significant economic growth. This economic growth, and the substantial increase in industrial production (Hjerppe, 1989; Myllyntaus, 1991), led to an increase in consumption of electricity. This progress also led to growth of the electric power industry, and is clearly evolutionary by nature.

In January 1947, after the Second World War, the government appointed a first Countryside Electrification Committee to carry out the electrification of the rural areas of the country. The government implemented the proposals of the Committee, which caused wide-ranging electrification in the country and as a result 260,000 new retail electricity customers entered the market between 1947 and 1960. The overall goal of countryside electrification was to stimulate the country's economy after the war; as the Committee stated in its report[62]: "…the main goal of countryside electrification is to increase the share of rural areas on the economy of the country,

[62] 'Maaseudun sähköistyskomitean mietintö 1950:9'.

which will have an important impact in leveling off the economical fluctuations. It is therefore natural that the interest and support of the society is targeted towards countryside electrification". The committee included wide expert help in the preparation of the report; in addition, the association of countryside electricity firms[63] was heavily involved in the preparation.

In order to make electricity an attractive energy source the government implemented electricity price regulation based on the Countryside Electrification Committee recommendations. Government subsidies to build electricity networks and power plants were also introduced. As a result, significant number of new electricity distribution firms entered the industry, particularly in the rural areas. In this case it was also the government that intentionally initiated the mechanisms. These mechanisms were, by nature, not directly coercive, but rather driving, as the subsidies were targeted toward rural distribution firms. Accordingly, they can be characterized as *causal and agency identifiable growth driving and accelerating mechanisms*.

Most of the new firms established as a result of countryside electrification either purchased their electricity from the larger power generation firms or established their own power plants. Due to chain of events described earlier, most of the new power plants utilized thermal technology.

Oil prices started to increase in the late 1960s not only in Finland, but all over the world and this culminated in the large hike in prices that caused the Oil Crisis of 1973. The oil price increases during the 1960s together with the Power Law in 1968, which caused the electricity prices in Finland to be frozen for a period between 1968 and 1972, and the profitability of the electricity firms using thermal technology and oil as raw material to decrease. This particularly hit the electricity distribution firms: between 1968 and 1971 the average financial result of the rural distribution firms

[63] 'Maaseudun Sähköyhtymien Liitto r.y.'

was negative (Simonen, 1973). The unit prices decreased when the size of the firm increased, which caused a positive impact for the result: the negative result (-0,2 p/kWh)[64] of the larger rural distribution firms (over 10,000 customers) was half of the negative result (-0,4p/kWh) of the smallest ones (below 5000 customers). On the other hand, the result for the population center distribution firms, which had a larger customer base and a more dense network area to serve, was positive (1,3-1,4p/kWh). Thus, the financial difficulties of the small rural distribution firms were caused by the combination of several mechanisms, depicted in the causal diagram in Figure 27.

Evolutionary path dependence, which had caused a technological lock-in to thermal technology, the environmental shock in the form of increasing raw material prices and the worldwide Oil Crisis in 1973, and the governmental *agency identifiable coercive mechanism*, which resulted from the price regulation together caused firm profitability problems.

These problems further acted as one of the key events leading to the final firm number decrease. The following three quotations from the discourse among the key stakeholders of the electric power industry during the beginning of the 1970s illustrate the first part of the process. First, Rainio (1970) stated in the 'Sähkö – Electricity' journal that ”the long-lasting price regulation will regularly skew the relative prices of distinct energy sources and thus cause demand distortion…thus the price regulation has caused serious anxiety among the electricity firms”. Second, in 1971, it was argued in the editorial of the annual report of 1970 of the Electricity Utility Association that “the price regulation increasingly hinders the ability to manage the finance of an electricity firm…those electricity firms, which are utilizing thermal technology, have faced particular difficulties, since their [production] costs have increased”.

Third, on March 3rd, 1974the Union of Finnish Towns sent a memorandum signed

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[64] The nominal price for electricity during 1965 was around 15 p/kWh

by Veikko O. Järvinen and L.O. Johansson to the minister in charge of the electricity price regulation, Jan-Magnus Jansson, in which they urged the price regulation to be relieved as soon as possible, since "the changed energy situation… and especially the tripled energy [raw material] prices have caused the losses of the [municipality owned] electric power firms to increase, which in turn has caused severe challenges for the public economy of the municipalities."

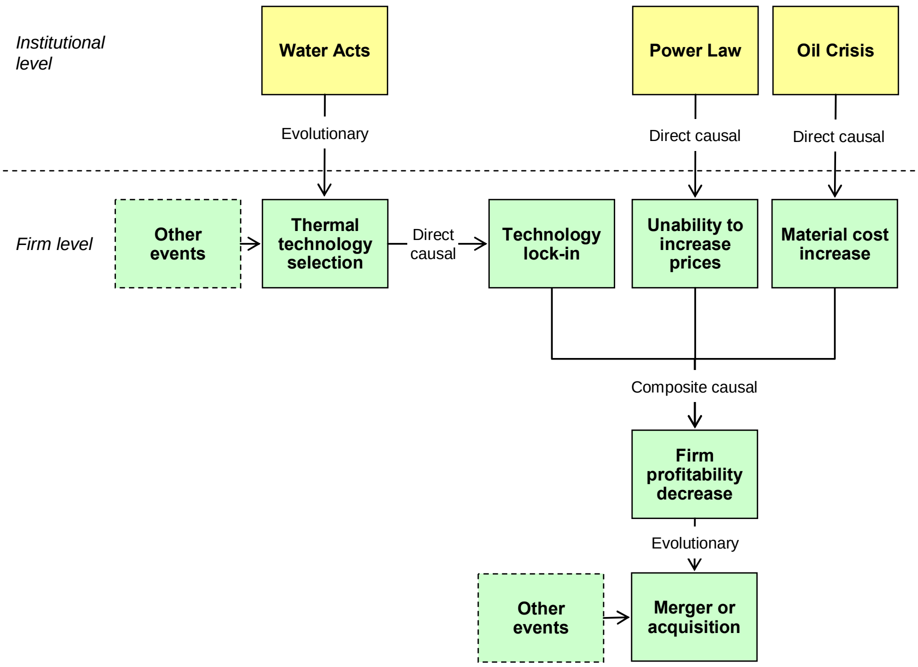

Figure 27: Combined causal impact of institutional environment and technological path dependence on firm survival

However, while the rural distribution firms experienced a heavy shakeout, the larger urban distribution firms survived due to their larger size, which gave them an economies of scale benefit compared to the smaller distribution firms. The analysis of the Electricity Distribution Organization Committee data shows that the economic performance of the larger electricity distribution firms was better that the smaller ones. Furthermore, as shown in Table 24, the vertically integrated business model that included power generation and which many of the urban electricity firms possessed, also acted as a survival factor against the external selection pressure.

Table 24: The share of firm without own production of all firm exits, 1970-1975 and 1975-1980. Source: Finnish electricity statistics 1970-1980.

Years	Number of firms at the beginning of the period		Number of exits during the period		Exit share of firms without own production	
	Total	Firms without own production	Total exits	Exits without own production	Within the group without own production	From all exits
1970-1975	570	316	206	153	48 %	74 %
1975-1980	418	193	38	19	10 %	50 %

Moreover, as Korhonen (2001) has also pointed out, utilization of the co-generation technology of heat and electricity gave an advantage to the largest urban distribution firms with own heat production and hence to their central heating customer. The analysis shows that vertical integration; a firm having both electricity distribution and supply operations, and power generation operations, had an overall positive effect on firm survival. From the firms that made an exit from the industry between 1970 and 1975, 74 percent had no own production or were not vertically integrated. This represents close to half of all nonintegrated firms in the industry. As a comparison, the share of vertically nonintegrated firms from all exits after the first shakeout, between 1975 and 1980 was still high at 50 percent. However, it was only ten percent for the group of firms without their own production.

Causal flow 1.2. Path dependence and institutional driving mechanisms and a feedback loop between the levels of analysis

The second causal flow explains the impact of an institutional driving mechanism that accelerated the natural evolution of the industry after the Second World War. After the war the rebuilding of the country and overall industrialization led to increasing demand for electricity, which in turn led to an increase in the number of firms in the electric power industry, boosted by the government supported countryside electrification actions. Driven by the natural evolutionary process and related mechanisms the maturation of the industry would, at some stage, have led to a decrease in numbers of firms. This evolutionary process was, however, mutated by causal mechanisms that were initiated by several institutional actors between 1947 and 1979. The analysis of the causes and effects are presented in detail in Table 25.

As described in the causal flow under subheading 1.1., above, government actions based on the first Countryside Electrification Committee initiated driving and accelerating mechanisms that precipitated the growth of the electric power industry. These mechanisms caused several intended effects to occur and the electrification was successful, as explained in Table 25.

On the other hand, the combined effect of natural evolution, the events and the subsequent causal mechanisms described in the causal flow 1.1., and the institutional driving mechanisms initiated by the Countryside Electrification Committee, also caused the occurrence of unintended effects. The quality of electricity distribution was uneven in the country; small electricity firms had problems with distribution quality, such as the number and length of power outages. The electricity industry association was worried about problems of the reliability of the small rural distribution firms and their ability to maintain the electricity network at the required service level and capacity.

Consequently, the second Countryside Electrification Committee[65], which endorsed the view of the industry association, recommended that ownership of the distribution firms should be broad-based and that the government should facilitate small rural distribution firm mergers. Based on the committee recommendations, the government implemented subsidies that accelerated mergers between the distribution firms. The result can clearly be seen in the descriptive statistics.

[65] 'Maaseudun sähköistyskomitean mietintö, 1966:A3'

Table 25: Analysis of the initial causes and effects within causal flow 1.2.

Causal event #1	Countryside electrification committee I[66]
Initial goal of event #1	→ *Overall goal*: increase the share of rural areas on the economy of the country to level off economical fluctuations → Establish a plan to electrify to electrify those rural areas that could be electrified with reasonable expenses → Propose forms of government subsidies for the electrifying process (such as direct financing, interest subsidies, and end-used entry fee leveling) → Propose tariffs or price regulation to enable viable business for the electricity firms as well as make electricity an attractive and competitive energy source for the end-users
Interest groups involved in preparation	The government of Finland Rural distribution electricity firm association[67] Wide group of experts (such as congressmen, industry experts and rural area representatives)
Primary effects of event #1 and type of mechanism	→ Proportion of electrified residences increased from 50% to 80% between 1947 and 1960, to 83% in 1964[68] and to 91% in 1970[69] [D,AI] → Electricity consumption in rural areas increased 58% between 1959 and 1964 (from 303 million kWh to 480 million kWh)[3] [D,A] → The standard of living increased in rural areas, which could be seen in the transfer from natural to monetary economy [D,AI] → Increase of small and medium size industries in rural areas[3] [D,A]
Secondary effect of event #1 and causal event #2	→ The quality of electricity distribution was uneven in the country; small electricity firms had problems with distribution quality, such as number and length of power outages. Larger organizations were proved to be able to be more effective in network building and maintenance as well as gain lower (volume based) prices from power producers[3][70] [EV,EM,U]
Effect of causal event #2	→ The countryside electrification committee II[3] proposed government subsidies for small rural electricity firms to merge with each other or to larger firms[3]. These subsidies were also implemented leading to various mergers[4].
Characte-ristics of the generative mechanisms	[D] – driving causal mechanism [EV] – evolutionary mechanism [EM] – emergent mechanism [A] – identified agency: in these cases government [I] – intentional: the initial goal of the agent became materialized [U] – unintentional secondary impact (due to combined impact of other parallel processes and mechanisms)

66 'Maaseudun sähköistyskomitean mietintö, 1950:9'
67 'Maaseudun Sähköyhtymien Liitto r.y.'
68 'Maaseudun sähköistyskomitean mietintö, 1966:A3'
69 'Maaseudun sähköistämisen loppuunsaattamistoimikunnan mietintö 1985:33'
70 'Sähkönjakelun organisaatiotoimikunnan mietintö 1974:46'

Moreover, an Electricity Distribution Organization Committee[71] 1973-1974, which was set up to “investigate, whether a better and even-handed service level for all electricity consumers could be achieved with centralization of electricity distribution to larger entities all over the country[72]” argued that “in the present conditions the small electricity distribution firms are no more able to offer a satisfactory service level…already the electric power purchase costs are disadvantageous for the small firms”. Thus, the Committee proposed that small electricity distribution firms should be merged with each other or with the larger firms in order to reach a larger minimum size of electricity distribution firm.

The chain of events in this causal flow is depicted in Figure 28. Two kind of driving and accelerating mechanisms from the institutional level can be identified. First, the Countryside Electrification Committee I initiated a mechanism that accelerated and mutated the effect of the evolutionary variation mechanism. Second, the Countryside Electrification Committee II and the Electricity Distribution Organization Committee initiated an *intentional and agency identifiable selection accelerating mechanism*. This causal flow also elucidates one of the macro-micro-macro feedback loops between the levels of analysis and the situational, action-formation, and transformational mechanisms.

The recommendations of the Countryside Electrification Committee I in 1950 and the subsequent government actions resulted in a downwards causation through a situational mechanism which caused firm numbers to increase significantly in the electric power industry after the Second World War. Several intervening and mediating events can be identified to explain this downward causation. Furthermore, the proximate causes of the action-formation mechanisms resulted in reliability problems, which caused the industry associations to support the merger of small distribution firm. Consequently, some 16 years later the second Countryside Electrification Committee decided to recommend government subsidies through a

[71] 'Sähkönjakelun organisaatiotoimikunnan mietintö 1974:46'
[72] 'KTM Energiatoimisto. Muistio 24.3.1972. Seppo Rautio'.

transformational mechanism, which mediated the information from the industry directly, and through the industry associations in particular.

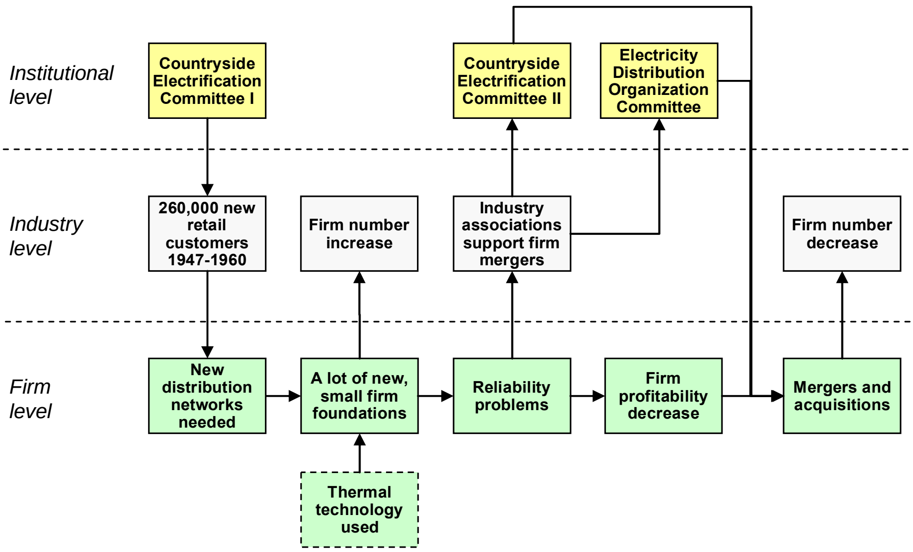

Figure 28: Macro-micro-macro feedback loop

Causal flow 1.3. Ownership changes leading to firm exits

The third causal flow explains the impact of ownership changes on firm mergers and acquisitions. Between 1970 and 1975, there was a substantial amount of firm mergers and thus exits from industry in two segments of firms: rural distribution firms and other industry or public sector power firms.

First, with regard to rural distribution firms, the change in the number of municipalities in Finland impacted directly to the number of electricity firm exits, particularly to the rural distribution firm exits. The number of municipalities in Finland increased steadily until the Second World War. However, the number decreased by 45 due to the cession of territories to the Soviet Union after the war. Thereafter the number of municipalities stayed stable until the political discussion of problems with small municipalities started in the 1960s. Consequently, a Small Municipality Committee[73] was set up in 1961 and it gave its report in 1965. The report proposed that municipalities below 8000 inhabitants should be merged with others. The Ministry of the Interior endorsed the proposals of the Committee in 1972, although a law was newer passed due to political disagreements (Niemivuo, 1991, Merisalo, 2007). However, the guidelines caused a major change in the number of municipalities; they decreased by 85 between 1965 and 1981 and by 41 during the first shakeout period of the electric power industry; between 1970 and 1975.

The long-term change in the number of municipalities in Finland between 1900 and 2005 is depicted in Figure 29. The impact of the municipality mergers, several of them coercive by the government (Niemivuo, 1991), was that the urban distribution electricity firms of these municipalities merged accordingly. Thus there was a *direct causal linkage* between the mergers of municipalities and the consolidation of the electric power industry. However, there was not an agent directly behind the effect, but it was an emergent result of the municipality mergers.

Second, the other two large exit groups during the period between 1970 and 1975, the manufacturing and other industry[74] and public sector electricity firms, were already earlier impacted by coercive regulatory causal mechanisms such as price regulation and the inhibiting regulatory causal mechanisms leading to the building of thermal power plants. However for these industries, there were additional mechanisms due to their specific business model and closely connected to their ownership model. In this model the owners of the firms where also the major customer of the firm.

[73] 'Pienkuntakomitean mietintö 1965:A:1'

[74] Excluding the forest industry electricity firms.

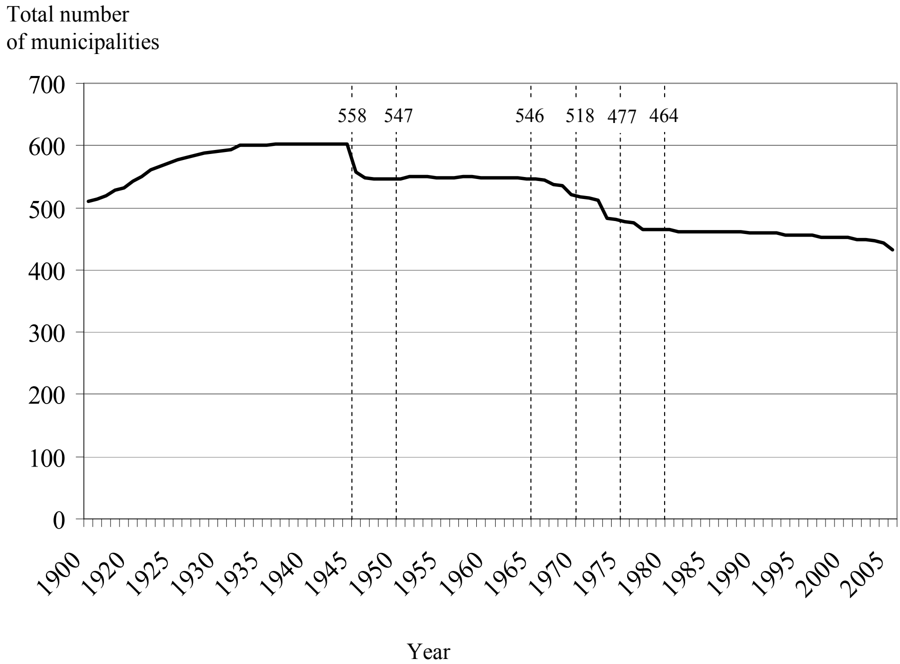

Figure 29: Number of municipalities 1900-2005. Source: Statistics Finland.

Thus the evolutionary selection forces stem from the coevolutionary relationship between the electricity firms and their owners. The Oil Crisis and the recession that followed (Hjerppe, 1989) caused many of the owner firms either to reduce, restructure or close their operations thus also causing corollary causal effects to the related electricity firms. From the group of firm exits there were a number of Finnish enterprises, where this kind of restructuring was took place such as Wärtsilä, Outokumpu, Osuustukkukauppa, Fiskars and Lohja. Consequently, many of the electricity firms they owned made an exit from the industry either through mergers or acquisitions. Moreover, public sector organizations such as the Defense Forces, the State Railways and the Road Office also restructured their electricity firms during the first shakeout period, between 1970 and 1975. These industries and firms, for which the cost of electricity formed a major share of their cost base, the increased oil and consequently the increased electricity price was one of the main causes for lowered profitability. Thus this mechanism was also acting from the electricity firm towards the owner firm. Accordingly, the low profitability then impacted back to the electricity firm. This kind of two-way, self-reinforcing mechanism can be either positive or negative for the electricity firm profitability and their survival.

To summarize, the impact of the ownership changes on the industry shakeout were both causal and evolutionary. The municipality mergers are typical events, which had a direct causal impact on the number of municipality owned distribution firm mergers. On the other hand, the changes in the industrial owners caused an evolutionary change to occur.

6.6.3. Key events and trends between the two shakeouts

The electricity legislation prior to the Electricity Market Act had restricted the ownership of electricity firms in Finland. The overall liberalization of the electricity markets in Europe led the national incumbents to extend their operations internationally. Consequently, Vattenfall from Sweden, E.ON from Germany, and TXU (Texas Utilities Company) from United States entered the Finnish electric power market by means of acquisitions. These acquisitions were part of the ongoing international expansion programs of the buyers, as deregulation had also opened markets in several other countries. The financial strength of the offering incumbents was substantial compared to the earlier mergers and acquisitions, which were mostly carried out between the local distribution firms. This led to an offering process, which was at its hottest between 1993 and 2000 that increased both the expectations and the realized prices of the sold distribution and retail operations. Thus that process increased the interest of the municipalities to sell their electricity firms, which again led to further acquisitions.

As a result of the early trends and long-term evolution of the ownership structures, the municipalities were major owners of the electricity distribution firms. The electricity firms were, prior to deregulation, a secure source of income due to their local monopoly and thus also provided a source for subliminal taxation (Ruostetsaari, 1998). However, The municipalities faced financial difficulties at the beginning of the 1990s due to the overall recession in the country. These difficulties, in combination with the willingness of the vertically integrated domestic and international incumbents to acquire the electricity firms owned by the municipalities, also caused the mergers of the distribution firms to continue gradually between the two shakeouts.

Consequently, in November 1990 the Ministry of Trade and Industry set up an Electricity Utility Committee[75] to analyze the development needs of the organizations and operations of electricity distribution utilities and firms. Moreover, the Electricity Utility Committee was set up to analyze the impact of the several mergers and transactions in the industry and the changes in ownership structures (Ruostetsaari, 1998). The Committee report was finalized in 1992. In the report, it stated that the number of electricity distribution firms had decreased from 230 in 1972 to 129 in 1990. The committee spotted (1) mergers between the distribution firms, (2) acquisitions by power generation firms, and (3) external investors entering the industry and acquiring local distribution firms as key reasons for the high number of market exits. The two first reasons were already identified in this research during the first shakeout period between 1970 and 1975. However, the international investors entered the industry after the first shakeout period. The Committee envisioned similar evolution in the form of market consolidation to also be continued in the future. Moreover, the Committee recognized the possibility that EU decisions might have an impact on the electric power industry. The Committee proposed several actions and the removal of regulation. Thus, in practice the Committee recommendations already covered the key content of the forthcoming Electricity Market Act.

The preparation of the new legislation continued directly after the Electricity Utility Committee work in the form of an Electricity Law Task Force[76] set up by the of Ministry of Trade and Industry. The Task Force report stated that most of the actors in the industry would benefit from deregulation. However, it was notable, that the

[75] 'Sähkölaitostoimikunnan mietintö 1992:15'
[76] Sähkölakityöryhmä

report indicated firm exits and industry consolidation would be continued: the group that would suffer from the new legislation would be the small distribution firms, which would be merged with larger firms.

Ruostetsaari (1998) argued that the roots of the 1995 Electricity Market Act were in the overall trends of liberalization and deregulation of the economy, which had already started in the 1980s. Moreover, the evolution of the electricity legislation in the UK, Sweden and Norway also acted as an example for Finland. In the UK the industry deregulated in 1991. Ruostetsaari (1998) also stated that the relatively distributed ownership of the electric power firms in Finland favored the fast implementation of deregulation in the country. The ownership structure in Finland, with strong municipal and industrial ownership in addition to the government distinguished Finland from countries such as Germany, France, and Italy, in which the government had, in practice, a one company monopoly over the entire value chain from power generation to distribution and sales and thus leading to slow progress in deregulation. On the other hand, there were other examples in Europe, such as the UK and Sweden, which also had wide-spread government monopolies similar to those of Germany, France, and Italy – but which implemented deregulation even faster that Finland. The distributed ownership cannot therefore be seen as a direct causal argument for the new Electricity Market Act. However, it certainly can be seen as a key feature of the industry in Finland, which has eased the process of deregulation. This is because there was no need to break up the government monopoly.

6.6.4. Causal analysis of the second shakeout episode 1995-2000

The key events prior to and during the second shakeout episode are depicted in Figure 30. The analysis shows that there were two key phenomena, related causal flows and particular mechanisms during the second shakeout period between 1995 and 2000.

These two phenomena are elucidated in the two causal flows, ‘industry restructuring’, and ‘opportunities and beliefs as intervening and mediating events for industry specific electricity firm exits'. All the identifiable mechanisms, which impacted firm survival or exits from the industry, were related to the new Electricity Market Act, the law that deregulated the industry. The new legislation, and its preparation process, included several events, which caused not only *opportunities* for the distinct actors to act, but also impacted their *desires* and *beliefs*. The desires and beliefs, on the other hand, impacted the content of the deregulation legislation, the 1995 Electricity Market Act.

Causal flow 2.1. Industry restructuring

The first phenomenon during the second shakeout period between 1995 and 2000 was *industry restructuring*. Together with the high number of firm exits (101 firms), for the first time since the early growth episodes the industry faced a relatively high number of firm entries.

The Electricity Market Act and the subsequent amendments declared that the different electricity operations should be unbundled from each other. Particularly important was the unbundling of electricity distribution operations from electricity sales and power generation operations. This unbundling first had to be done operationally and from the beginning of year 2007 the firms had to be broken up as separate legal entities. The unbundling is a key explanation behind the relatively high number of firm entries after the enforcement of the Electricity Market Act: in total 55 new firms were established between 1995 and 2000, out of which 20 were new power generation firms (representing a 47 percent increase) and 14 were electricity sales firms. The pace also continued during the next five year period, although with a lower rate, with 29 new firms established during the period between 2000 and 2005. The restructuring also caused three new business models to be created: the electricity retail and electricity trade firms[77] were first established after 1995. Moreover, a new type of electricity distribution firm, a regional network

[77] In the statistics the electricity trade firms are totalled together with the electricity sales firms.

operator responsible for medium distance power transmission, was created after deregulation.

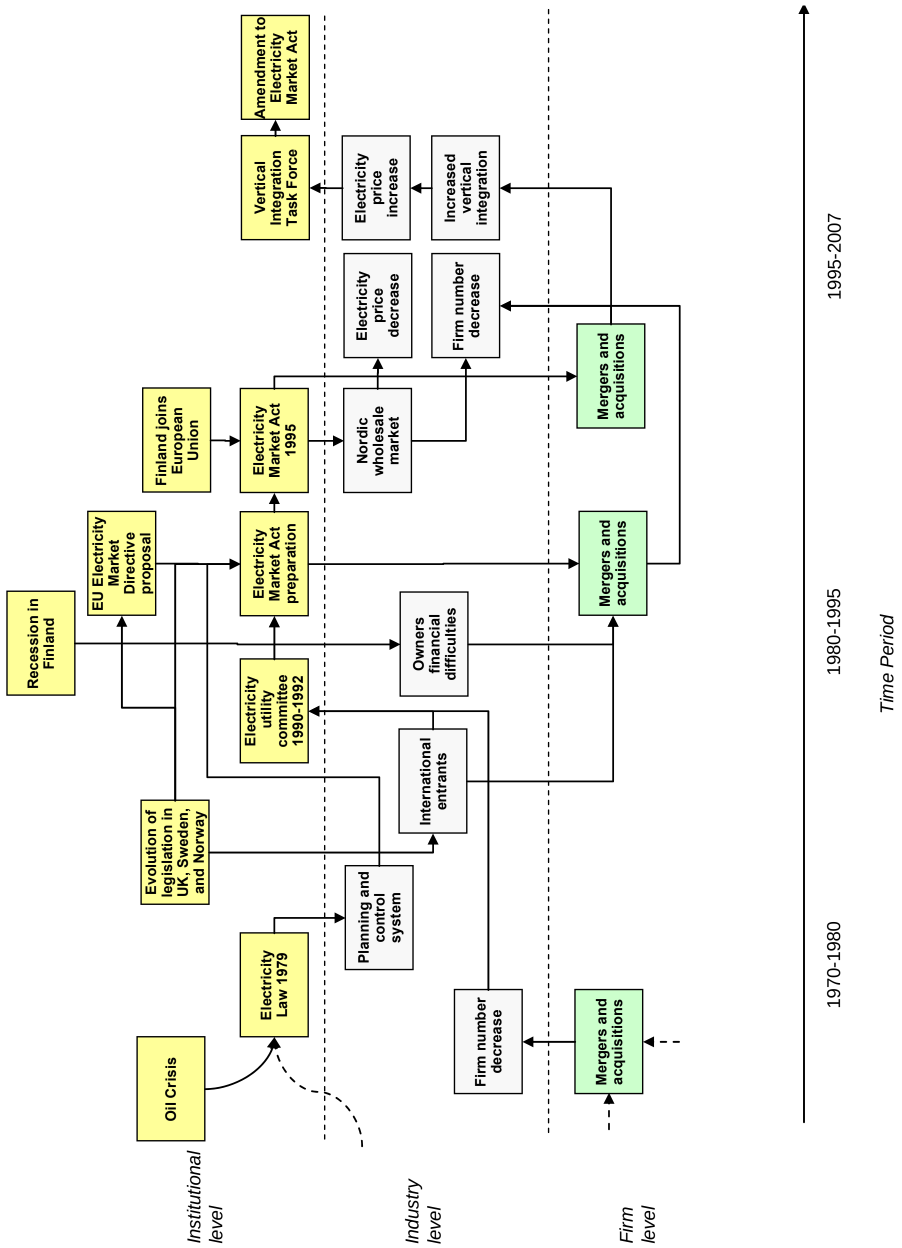

Figure 30: Event analysis leading to the second shakeout episode 1995-2000

The foundation of a joint electricity sales firm, Kymppivoima Oy in October 1993, combining the sales operations of ten large electricity distribution firms is a good example of the process of industry restructuring. Häikiö (1996:134-144) explained the process that led to the establishment of Kymppivoima, from the viewpoint of the largest of the shareholders, Savon Voima Oy. The process started in 1991, when the management of Savon Voima familiarized themselves with the deregulation process of the electricity markets in other European countries. Consequently, market liberalization was selected as the focus area in the 1992 strategy process. In the 1992 strategy it was stated that "the competition will stretch first the largest customers, but then possibly to all customers". The board of directors made an excursion to England to acquaint themselves of the deregulated electricity market in the country. The excursion strengthened their view about the upcoming competition. The company was particularly worried about the forthcoming competition within the large customer segment and felt a pressure on electricity purchase prices. As Häikiö (1996) stated, there was a gentlemen's agreement between Imatran Voima and the distribution companies that Imatran Voima would not enter the electricity distribution business and the urban electricity distribution firms would not enter power generation at a large scale.. Thus many of the electricity distribution firms purchased electricity mainly from Imatran Voima. Savon Voima and other urban electricity distribution firms, which prior to deregulation engaged in electricity sales activities, negotiated about bulk discounts with Imatran Voima but without results. To join their forces and to gain a stronger negotiation position against IVO, the ten urban distribution firms merged their sales operations into Kymppivoima Oy in 1993. Thus the beliefs of the forthcoming competition caused by deregulation and the path dependent lock-in to the specific business model caused the sales operations merger and for the establishment of new firms to occur.

One of the key rationale for the power generation firms to acquire electricity distribution firms was to ensure (and extend) their market share after deregulation (Ruostetsaari, 1998). With new actors in wholesale market segment the large power generation firms, such as IVO, faced competition in wholesale electricity sales in the new market and this increased the potential for these power producers to lose customers. The more direct end consumers a power generation and wholesale firm has, the less it has to worry about the wholesale competition. Consequently, this business logic has been one of the key drivers for large power generation and wholesale firms to acquire electricity distribution and sales firms. The retail market information that the distribution firms possessed was considered to be the key to success for the power generation firms in the retail business (Pineau and Hämäläinen, 2000). Due to this trend and the concerns among the electricity distribution firms, the Ministry of Trade and Industry set up a Vertical Integration Task Force, which gave its report in the spring of 1997. The Task Force found that the total electricity prices for the end customers of the vertically integrated IVO and Vattenfall were statistically higher than the prices for the customers of the other firms. The Task Force proposed that electricity sales and distribution firms should be legally separated according to the Swedish model, the monitoring of the pricing of the electricity sales and distribution prices should be improved, and that the maximum ownership of electricity distribution capacity for one company in Finland should be restricted to 20 percent. Later, in the spring of 2002, the limit was enacted in the restraint of competition law at a level of 25 percent in the 400 kV distribution networks. Based on the recommendations, an Amendment to the Electricity Market Act was brought into force legal separation from the beginning of year 2007.

As legislation evolves so also does the related mechanisms that impact the industry and the firms within the industry. The *restructuring mechanism*, which acted behind the selection and variation of business models evolved from a directive evolutionary mechanism to a coercive causal mechanism as the content of the regulation changed. The new amendment to the Electricity Market Act which obliged the larger firms to separate the sales and distribution operations also, from the beginning of year 2007, legally caused the restructuring mechanism to evolve to a coercive causal mechanism.

Causal flow 2.2. Opportunities and beliefs as intervening and mediating events for industry specific electricity firm exits

The second phenomenon during the second shakeout period between 1995 and 2000 was the *high number of manufacturing electricity firm exits*. In total 78 manufacturing electricity firms disappeared from the market, out of which 26 were from the forest industry. The explanation can be found in the basic arguments of wholesale deregulation: as there was a competitive wholesale market present for electricity, the manufacturing firms were able to purchase electricity either directly from the electricity exchange or from the large wholesale suppliers such as Fortum or Vattenfall, and there was no longer a need to have an own firm for that purpose. Thus the rationale behind the industry specific electricity firm to exit during the second shakeout, after deregulation, can be derived from transaction cost economics (Williamson, 1971, 1985) theory: after opening of a competitive wholesale market, the government controlled planning mechanism was abolished and substituted by market mechanisms. The uncertainty of the environment in terms of the costs of continuing with a business model where the electricity operations[78] the of the industry was kept as an own firm owned by the industry, no longer existed compared to the direct purchasing of electricity from the market. Also the expectations were that the new legislation would decrease the price of electricity, as stated in the preamble of the Government proposal for the Electricity Market Act[79], "the industries that use electricity can in the future purchase their electricity from the most affordable source. The small and medium size industries would evidently gain more. According to some estimates their electricity cost gain would be up to 10-15 percent. Thus the impact for the national economy level would be substantial."

Thus the new regulation changed the industry characteristics so that it gave an opportunity for the actors to exit their electricity firms from the market. In this case the causal link between the institutional level change in regulation and the firm

[78] In some cases with vertically integrated operations included power generation and supply, in some other just the supply of electricity.
[79] 'Hallituksen Esitys HE 138/1994'

number decrease can be explained with an *intervening and mediating* event, the market formation gave an *opportunity* for the manufacturing firms to withdraw their electricity firms from the market. If the firms possessed power generation or distribution assets, those assets were then divested to other firms and the electricity was purchased directly from the wholesale market. There was a belief among the industry that the competition would increase after deregulation and that larger firms would be more competitive that small ones, as the two following quotations illustrate. First, in year 1994, it was argued in the editorial of the annual report of 1993 of the Electricity Utility Association that "the electricity firms have prepared themselves for the new electricity market…with increased competition. This preparation has manifested itself as firm mergers, municipal utility incorporations, establishment of new co-operation firms and as personnel reductions." Second, in the preamble of the Government proposal for the Electricity Market Act[80] it was stated that "the increased number of firm mergers during the last years may have boosted due to the preparation of the Electricity Market Act…the electricity retailers have already, before the implementation of the new law, started to establish electricity procurement and sales firms. It is evident that small supply firms will also be merged in the future. However, it is impossible to estimate the impact of the Electricity Market Act on the quantity of mergers, especially because of the ongoing consolidation process due to other causes."

In addition, there was according to Ruostetsaari (1998), a belief among the other industries – based on the preparation work of the Electricity Market Act – that vertical integration would be restricted in the new law and therefore the power generation firms would not be able to carry on electricity distribution business. Thus the industrial owners of electricity power firms appeared to be misguided by the final forms of deregulation as they hurried to divest their electricity distribution firms in the belief that vertical integration would be restricted in the Electricity Market Act. This *belief* acted as an intervening and mediating event that caused the

[80] 'Hallituksen Esitys HE 138/1994'

mergers and acquisitions. Thus the *belief of vertical integration restriction* and the *opportunity to purchase electricity directly from the market* represent partly, but not fully the restructuring mechanism. The *legal coercion* to separate electricity distribution from electricity generation and sales as legal entities forms another representation of the mechanism that influenced the the evolution of the industry at a later stage. The graphical presentation of these intervening and mediating events is shown in Figure 31.

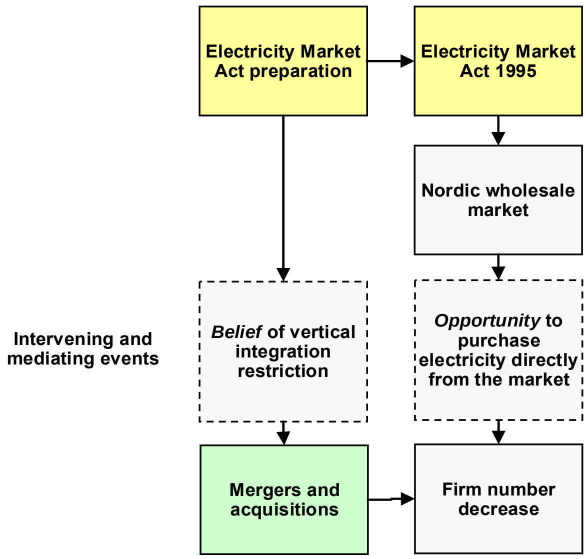

Figure 31: Beliefs and opportunities as intervening and mediating events

All in all, the law preparation has already led to consolidation of electricity distribution; this is evidenced by the statement of congressman Louekoski in the parliamentary discussion about the proposal for the new Electricity Market Act[81]: "Already when the law preparation started in the Ministry of Trade and Industry the owners of distribution firms started to trade with the firms. Especially those small

[81] 31. 187.1994 9) HE 138/1994 1 K Ed. Louekoski (31.01.1995)

firms, which have concentrated on electricity distribution locally, and who do not possess production capacity of their own, have been put up for sale and the buyers have been the larger distribution firms acting in the neighboring area. This trend has been remarkably extensive and seems to continue all around the county. In other words the Electirity Market Act coming into force and the very preparation of the law has led to electricity distribution consolidation".

7. DISCUSSION

Causality has reached limited attention as part of the evolutionary explanation of how industries evolve, why certain firms survive while others do not, and how the institutions impact the natural lifecycle of industries. The key contribution of this research is that it offers causal arguments as new and complementary components to the evolutionary explanation. The research shows that causal mechanisms provide additional explanatory power to explicate the fine-grained elements of long-term change. Moreover, it shows that multiple levels of analysis are needed in order to give meaningful causal explanations in evolutionary research. This research has three key findings, which provide answers to the research questions. The findings represent contributions to structural constructs of the industry evolution explanation, formation of selection criteria, and patterns of industry life cycles. The details of the key findings are discussed in the following sections.

First, the analysis shows that the fine-grained mechanisms that provide explanations for long-term evolutionary change can be characterized either as *evolutionary* or *causal*. In addition, they are by nature either *emergent* or *agency identifiable*. Second, the business model of a firm was identified as a key evolutionary selection criterion. The formation of a business model was effected by both evolutionary and causal mechanisms. Thus the selection process could be explained more explicitly through the use of mechanisms. Third, the pattern of a regulated industry life cycle was, to some extent, dissimilar to the life cycles of traditional open market industries (cf. Klepper, 1997). The divergence can be explicated with causal explanations and by means of the effects of causal mechanisms. They affected the fundamental interplay of institutions, technology, and the market in the industry and caused two shakeouts to occur. Two kinds of events that induced the mechanisms were identified in the research: public policy measures and external shocks. The causal effect was clearly identifiable in a regulated industry, in which the impact of institutions, in the form of legislation, regulation and public policy measures was palpable on the industry. It could be argued, however, that similar kinds of causal effects can also be identified in other types of industries.

7.1. Nature of mechanisms in evolutionary explanation

The existing industry evolution and evolutionary economics literature shows that mechanisms are useful constructs to explain the more fine-grained occurrences beneath the high-level evolutionary change processes. The nature of mechanisms as part of the evolutionary explanation in the existing literature is considered to be principally *evolutionary.* For example, such general mechanisms as 'mechanism to winnow the variation', or 'selection mechanisms' (Nelson, 1995b) are by nature evolutionary. Several evolutionary mechanisms were also identified in this research. These evolutionary and emergent mechanisms created emergent and episode specific force fields, which reflected the rules of periodic games in society and in the industry and further impacted the change process and the structure of the industry in the subsequent phase. However, all fine-grained processes cannot be explained with evolutionary mechanisms and causal ambiguity. As a result of external interventions – such as public policy measures or environmental shocks in particular – there acts also other kind of mechanisms: mechanisms with a causal nature.

On the other hand causality, causal methods and causal mechanisms have been broadly used in social sciences. Causality has evolved over the years from a mysterious concept to mathematical models. This has led to ‘law-like’ explanations (Runde, 1998) and rigorous predictions (Pearl, 2000). Recently, based on the research of Pearl (2000), Machamer et al. (2000) and Goldthorpe (2000), Hedström (2005) proposed a next level of causal reasoning, causal *explanation with causal mechanisms* as a contrast to law-like causal predictions. According to Hedström (2005) “mechanisms should be seen as theoretical propositions about causal tendencies, not as statements about actualities ... they might be inadequate to predict actual outcomes, because also other processes work at the same time” (2005:108).

Explanations with causal mechanisms are particularly appropriate for extending evolutionary explanations, since both mechanism based explanations and evolutionary explanations are process-based and have a temporal nature. The explanation of evolutionary change processes needs to go beyond surface descriptions, variable methods and statistical explanations (cf. Walsh, 2007[82]) to elucidate the logic behind observed temporal progressions and to identify the generative mechanisms that cause observed events to happen (Van de Ven and Poole, 2005). Or as Mayntz (2004) has put it: "statements about mechanisms are links in theory; they are causal propositions that explain specific outcomes by identifying the generative process that, given certain initial conditions, produces them" (2004:253). Mechanisms enable filling of the the gap between high-level evolutionary theory and VSR processes and the empirically identified phenomena. Hence they are useful building blocks of middle-range theories (Merton, 1957; Mayntz, 2004).

On the other hand, as mentioned earlier, the identification of mechanisms is challenging because empirical representations of mechanisms (Bunge, 2004;

[82] There is a recent discussion between the two competing interpretations of the synthesis theory of evolution (Bouchard and Rosenberg, 2004; Stephens, 2004, Millstein, 2006; Shapiro and Sober, 2007). According to the dynamical accounts, evolutionary chance such as selection and drift are causes of population change (Reisman and Forber (2005). On the other hand, according to statistical interpretation, evolutionary selection and drift are not causes of population change; they are mere statistical effects (Matthen and Ariew, 2002; Walsh et al., 2002; Walsh, 2007).

Mayntz, 2004) do not exist. There are, however, methodological solutions to the identification of mechanisms (Machamer et al, 2000; Goldthorpe, 2001; Glennan, 2005). Moreover, Pearl (2000) suggested rigorous episode-specific evidence gathering as a basis for making claims about actual causes. Building on the aforementioned existing body of knowledge, in this study I used a methodology in which I first summarized the findings of a historical event analysis and a descriptive numerical analysis in a form of causal diagrams (Pearl, 2000). Based on the behavioral description (Glennan, 2005) of the phenomenon presented in the causal diagrams I subsequently analyzed and described the characteristics of the generative mechanisms.

The focus of this study is on the interplay of the institutions with the underlying market and technological evolution of an industry. Therefore the mechanisms that have been identified are, by nature, 'metamechanisms' (Bunge, 2004) in contrast to the 'micromechanisms' found in biology such as mechanisms transmitting neural signals across synapses (Machamer et al., 2000), or intra-firm mechanisms such as those explaining decision making within industrial firms (Pajunen, 2004, 2008). One of the key characteristics of micromechanisms is their internal structure and hierarchical organization (Bechtel and Abrahamsen 2005; Machamer et al., 2000; Pajunen, 2008). In organizational science, micromechanisms are useful constructs to explain micro-evolution (Lewin and Vorlberda, 2003) within organizations. However, the internal structure of mechanisms is not the focal interest of institutional metamechanisms and longitudinal studies. On the contrary, the focus is on coevolution between several processes at different levels of analysis (Volberda and Lewin, 2003); long chains of intervening and mediating events (Pearl, 2000; Morgan and Winship, 2007) in the distinct levels of analysis and the causal mechanisms that intervene the 'natural evolution' of an industry.

Indeed, in evolutionary explanation the evolutionary process is the backbone of the explanation and thus causal mechanisms provide only partial explanations - the long-term explanation comprises the combined effect of both the evolutionary and causal mechanisms. Hence, the underlying evolutionary process and the related mechanisms provide an answer to a counterfactual question of "what would have happened" without the institutional events and the effects of the mechanisms that they initiated.

This research shows that some of the evolutionary mechanisms can further be explained with mediating and intervening events and thus the full mechanism is represented by its component parts and with the mediating and intervening events. The two distinct types of mechanisms, causal and evolutionary, and their combination are depicted in Figure 32.

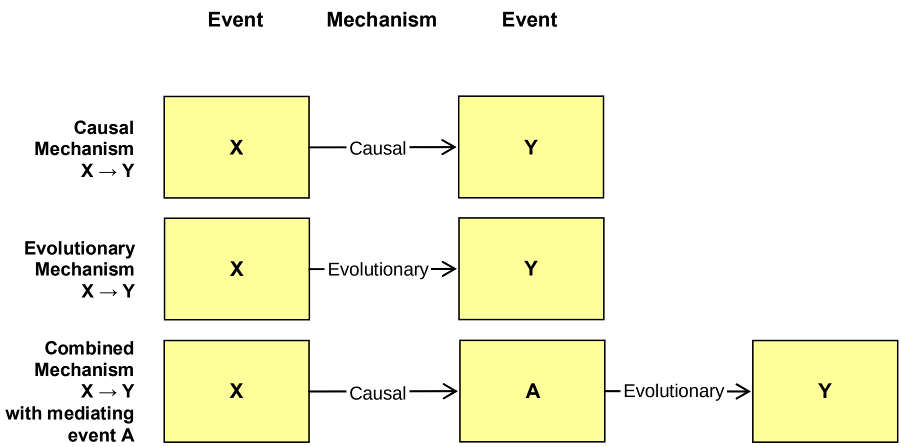

Figure 32: Evolutionary and Causal Mechanisms

On the other hand there are cases in which the intervening and mediating event is not part of the internal structure of the mechanism. Rather, the intervening and mediating event is shared with another chain of events or process, which is in a co-evolutionary relationship with the process in focus. In these kinds of cases the result is an impact of a combined effect of the two co-evolutionary processes. An example of this kind of combined impact is presented in Figure 33.

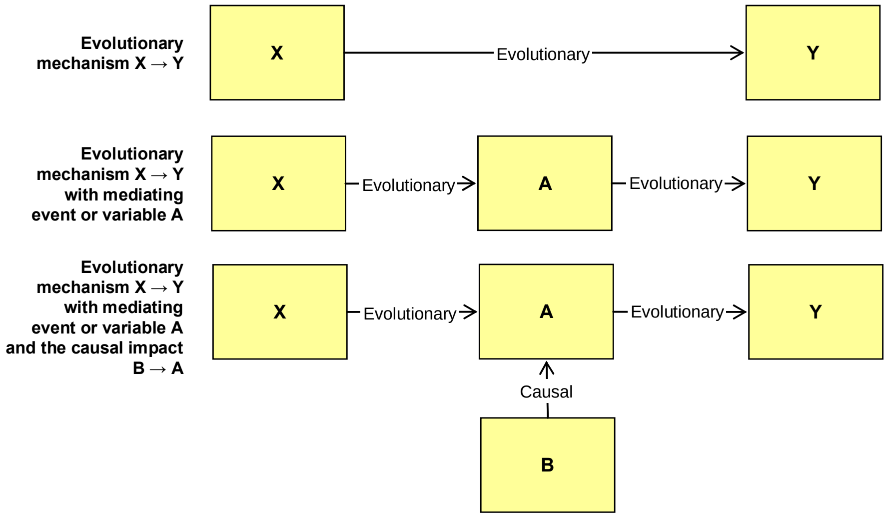

Figure 33: The combined impact of both evolutionary and causal mechanisms

An example of the impact of regulation on the evolutionary selection process elucidates the combined impact. Under normal open market circumstances market mechanisms are active. Thus the evolutionary selection mechanism X → Y selects the most profitable, and as has been shown by the existing research, the ones with the most competitive[83] technology, to survive. However, if a regulation event B restricts or prohibits the exploitation of the most competitive technology to date or if it limits the profitability prospects of firms with price regulation, it induces a causal mechanism B → A, which impacts the selection criteria A. Consequently, the impact of the evolutionary selection mechanism X → Y is changed.

Furthermore, one key characteristic of an evolutionary mechanism is that it is ontologically *emergent* in the sense that it is not additive, not predictable from knowledge of its components, and not decomposable into those components (see

[83] As the literature review shows, the 'most competitive' technology might be either the most advanced as a result of R&D investments, or the dominant design of the industry.

Sawyer, 2001). On the other hand some scholars (North, 1990; Durand and Calori, 2006; Hodgson, 2007) have highlighted the role of *agents* and their purposive activity as key explanations for change processes. In addition, an extension of the research framework to include multiple levels of analysis – as in this research – raises the need to include the role of agency in the methodology (Felin and Hesterly, 2007). Indeed, the findings of this research support the view that political decision makers have an agency effect and are using a 'visible hand' (Chandler, 1977) with causal impact – sometimes purposively, sometimes unintentionally – which has impacts on survival of firms and on the overall industry structure. In addition, this research, together with the key findings of earlier studies (Ruostetsaari, 1989, 1998), provides empirical evidence that the firms in the electric power industry and industry associations acted as agents with an identified causal impact on the institutions and public policies of the country.

7.2. Characteristics of a regulated industry evolution

There are two interesting findings in the research of a regulated industry evolution. First, the industry life cycle contrasted with the open market industries life cycles due to the impact of institutions. Second, the business model of a firm was identified as a key selection criterion during the life course of the industry and, in particular, during the shakeouts.

7.2.1. The impact of institutions on industry life cycle

The findings of this study provide support to industry life cycle (Klepper, 1997) research with an interventional (Woodward, 2003) causal explanation; the effect of the market mechanisms in a general industry life were manipulated through the effect of the mechanisms initiated by government actions. And vice versa; the explanation provided by industry life cycle research gives us a counterfactual explanation on regulated industries; it explains what sort of difference it would have made for the explanandum (number of firm entries and exits in a regulated industry) if the factors in the explanans (government regulation) would have been different (such as no regulation at all).

The pattern of industry life cycle in a regulated industry, as identified in this research, follows the general pattern of industry life cycle defined by Klepper (1997). However, the research shows that the general pattern was affected by institutions as well as by external shocks – and induced by either agency identifiable or emergent causal mechanisms. Thus *Proposition 1* is supported. There are key distinctions in the three stages of evolution of the electric power industry compared to the 'market-based' industries and the related research.

The first is the initial stage of industry life cycle. At this stage the fundamental characteristics of regulated and market-based industries are equal: the market volume is low; uncertainty is high, technology development is in an early stage, and firm entry rate is high. However, in a regulated industry there are two key distinctions: competition is restricted by legislation and regulation and product innovation exists, but regulation restricts exploitation of innovations and technology, and utilization of raw materials. The central facts are similar at the second stage of the industry life cycle. At this time output growth is high, and the design of the product begins to stabilize. In open market industries the competition and the market rules specify the selection criteria as they push down industry prices after the growth phase. Returns from R&D provide an advantage to the earliest entrants, which forces the smallest and least capable innovators out of the industry and thus contributing to a shakeout. In a regulated industry, it is not only the benefits of R&D and the utilization of the technology, but in a noteworthy way it is also the property rights, license based advantages, and ownership structures that provide an advantage to certain types of firms who have the right business model. Even if a firm is among the early entrants, regulation might restrict the firm's expansion or its opportunities to exploit technologies. Thus the selection of the right business model in the light of current and foreseeable legislation and regulation, consequently influencing the institutional environment, become key advantages for a firm to ensure their survival.

Moreover, during the shakeout there is significant institutional inertia (Djelic and Ainamo 1999) in the regulated industry, which slows down the shakeout. This inertia acts as a social mechanism which is caused by public ownership structures and firms organized with business models of stability and control -for example vertical integration. In the third stage, the mature stage, output growth slows, entry declines further and market share stabilizes. However, because the ‘rules of the game’ are not defined by the market, but by regulation, major changes in the institutional environment such as new regulation or deregulation act as an environmental shock for the firms and may have significant impact on individual firm survival. The deregulation of the Finnish electric power industry in 1995 offers good empirical evidence for such an incident; this caused another shakeout for the industry.

7.2.2. Business model as a selection criterion

The analysis shows that the dominating selection criteria that impacted firm survival were the *business model* of a firm in addition to its size, the power generation technology it possessed, and its ownership structure. This is notable, as it differs from the selection criteria identified in the previous studies of industry life cycles, which highlight the role of technology and R&D (Klepper, 1997). On the other hand, it is compatible with the arguments of population ecologists, who point out that the organizational form of a firm is a key selection criterion (Hannan and Freeman, 1977). Three key reasons can be identified for the difference between industry life cycle research and that which predominantly concentrated on open market industries.

First, the impact of innovation and R&D are less important in regulated industries in comparison with others operating in a pure market environment. Therefore the benefit of age is non-identifiable, as there is no race to be technically ahead of the competition in the early phases of the industry.

Second, size is important in both kinds of industries, but for different reasons. In open market industries the benefit of size is that it contributes to the ability to invest on R&D and thus gain advantage over competition with fewer resources. However, in electric power industry, the benefit of size comes primarily from economies of scale leading to relatively better profitability than the rest of the industry. This applies to both electricity distribution and power generation. From the owners’ point of view, even in regulated industries profitability is after all a key decision criterion for whether to retain or divest a firm.

Third, the analysis shows that during the shakeouts the non-vertically integrated specialized firms had the least chances of survival. On the other hand, the survival of vertically integrated business models can be explained by the *excess capacity* (Hannan and Freeman, 1977) that firms with that kind of business model possessed. The excess capacity of firms enabled them to redirect their resources in times of change.

The business model had an impact through two mechanisms: *institutional coercion* and *technological lock-in.* In addition, the analysis shows that industry structure and firm survival was a result of the interaction of direct causal mechanisms of public policies and the evolutionary path dependence and asset constraints and the related evolutionary mechanisms. Thus, both *Proposition 2* and *Proposition 3* are supported. The combination causes far-reaching impacts on public policies at both industry and firm level. These outcomes are sometimes, as has been shown here, different from the goals of the initial purposive actions, as the process has been interfered by the underlying or emergent evolutionary processes and related mechanisms.

In addition, the exploitation of power generation technologies as a key component of the business model was also substantially impacted by the surrounding institutions and the related individuals. This is illustrated by the following two examples from the previous research. First, in research in Finland Ruostetsaari (1989) identified several institutional *subsystems* (Self, 1972; Jordan, 1981; Rose, 1980) that was constituted of public and private actors who were interested in certain energy sources and the related technologies. The wide range of actors in the subsystems included political parties, industrial organizations and governmental institutions. The key subsystems, which were evolved around different energy sources after the Oil Crisis in the 1970s and 1980s, included (1) domestic fuel, particularly peat, (2) natural gas, and (3) nuclear power. Ruostetsaari’s (1989) key argument was that the determination of energy policy in Finland was at least partly explained by the subsystems. Thus the determination of the technologies to be used in each time period was not purely impacted by the technology itself, but by the effect of the related subsystems and their actions. However, Ruostetsaari (1989) noted that “when purely economical stimulus to change the energy policy is forceful enough, the impact of the institutions and organizational setups [such as subsystems] are insignificant” (1989:308). As examples of economical stimulus he used the technological changes from animal power to wood, from wood to coal, from coal to oil and further from oil to nuclear power, and to sustainable energy forces. These changes in energy production sources and the related technological changes caused an inevitable change to occur (Lucas, 1985).

As a second example, Myllyntaus (1991) showed that the roles of individuals and the supporting institutional framework with education and government support enabled Finland to utilize the new technology and carry out electrification of the country at least as rapidly as the other European economies, and without excessive reliance on foreign involvement, even though the country remained predominantly an agricultural economy for much of this period. In addition to the role of individuals he highlighted the role of government and related institutions to the evolution of the industry and concluded that even if the government had a major role in hydropower plant development and the establishing of the nation-wide transmission network “the government regarded large-scale electrification and the utilization of hydropower more as a political than an economic or technological question” (p.71).

In addition to Myllyntaus (1991), Ruostetsaari (1989) highlights the role of individuals. According to him, the informal personal contacts played a central role in making of the Finnish energy policy in the 1980s (Ruostetsaari, 1989) and the informal personal contacts had a significant impact in public exercise of power (Ruostetsaari, 1998). It is obvious, that although not part of the research framework, individuals as microfoundations of organizations as the lowest level of analysis have to be recognised. There are two standpoints regarding the significance of individuals each representing distinct epistemological and methodological traditions; methodological collectivism and methodological individualism. Although the two standpoints have traditionally been seen as contradictory, their borderline has become blurred and the two doctrines no longer appear as clear-cut opposites (Udehn, 2002). The ‘structural individualism’ or ‘weak form of individualism’ presented by Coleman (1990) and Hedström and Swedberg (1998) and the consequent literature offers a mix, or synthesis, of individualistic and holistic elements. In structural individualism the social structure is seen “as a system of interrelated positions that is relatively independent of individuals, at least of each particular individual” (Udehn, 2002:496).

However, it has been common in the evolutionary economics tradition to abjure behavioral complexity (Nelson and Winter, 1982) and the microfoundations of organizations. In their theoretical paper, Winter et al. (2003) presented ‘a baseline model for industry evolution’, where they note that they have resolved a number of issues of microeconomic foundations with quite simple assumptions. In their model they neglect the impact of individual actors “when simpler alternatives are adequate to explain aggregate phenomena and there exists no direct empirical support for the more complex assumptions” (Winter et al., 2003, p.357). Furthermore, selecting the organization as the lowest level of analysis often implicitly means that methodologically the lower levels are considered to be homogenous. Or to put it in another way, as Howard Aldrich has stated in his co-authored paper: “if we truly focused on routines, competencies, and practices and so on, we would not follow people any more in our research...people would disappear from our equations” (Murmann et al., 2003).

Institutional theorists, do however highlight the importance of individuals. For example, North (1990) argued that “organizations and their entrepreneurs engage in purposive activity and in that role are the agents of, and shape the direction of, institutional change” (p.73). Moreover, Barley and Tolbert (1997) claim that “through choice and actions, individuals and organizations can deliberately modify, and even eliminate institutions” (p.94). Furthermore, neglecting the impact of individuals as the lowest level of analysis has been challenged by recent research. Felin and Hesterly (2007) provided evidence that individuals play a big role in creating new value in knowledge intensive industries. In addition, Durand and Calori (2006) challenged the ‘sameness or homogeneity within organizations and they argued that powerful agents influence organizational change processes.

In this research, the focus is on the interplay between industry and the market, technologies, and related institutions. However, as is the case at the other end of the hierarchy of the levels of analysis, the surrounding society and the key events in society has to be taken into account when forming the causal explanations. Similarly the lowest level of analysis, the agents cannot be neglected. In causal analysis the purposive nature of the agents in activating the mechanisms that cause the change to occur has to be taking into account. Indeed, it is the synthesis of methodological collectivism and individualism that is needed to add causal mechanisms as a complementary component to the evolutionary explanation.

8. CONCLUSIONS

8.1. Theoretical contributions

The key concepts of this research, causal and evolutionary mechanisms, originate from the existing body of knowledge in industry evolution and evolutionary economics research. Evolution is not just a process of aging in which the processes of variation, retention and selection shape populations. It is the *interplay* between institutions, such as legislation, regulation and public policy actions, technology and related firm assets, and the market, and the competitive forces that collectively form the key explanatory factors behind long-term change; industry life cycles and shakeout, changes in industry structures, and individual firm survival (Nelson and Winter, 1982; Nelson, 2005; North, 1990; Klepper, 1997). Mechanisms represent the fine-grained constructs of the evolutionary explanation (Nelson, 1995b; Murmann, 2003).

Complementing existing research this study provides four key contributions. First, the research offers causal explanations as a complimentary element to providing a full evolutionary explanation. Second, in addition to the existing constructs, the research findings presented in this dissertation provides evolutionary explanations through mechanisms, which are either evolutionary or causal, and either emergent or with identified agency. Consequently, the long-term change is a result of the interplay of both the causal and evolutionary mechanisms. Third, the research framework presented in this research provides multiple levels of analysis. This is much is needed to be able to give causal explanations in evolutionary research. Fourth, compared to the existing studies of industry life cycles, the causal explanations provide elucidation of the differences in the industry life cycle caused by public policy actions and external shocks.

8.2. Practical implications

In addition to the theoretical contributions, there are four key findings of this research with practical implications for public policy makers, and for stakeholders of electric power industries – and for the management of electric power firms in particular.

1. Public policies have primary causal and secondary emergent impacts on industry structure and firm survival. The emergent impacts are a result of the interplay of the direct causal mechanisms and the underlying evolutionary mechanisms.
2. Evolutionary path dependence and asset constraints cause far-reaching impacts of public policies on both industry and firm levels.
3. External shocks intervene the 'normal' evolution of the industry and the intended causal impacts of public policies.
4. A firm's business model and vertical integration act as a key selection criteria both prior to and after deregulation.

Understanding long-term evolutionary change is essential to the building of long-lasting strategies and to the planning of the actions required for the long-term survival of a firm.. Moreover, it is fundamental for public policy makers to understand the underlying evolutionary process and the related mechanisms and their interplay with the purposive actions of public policy makers. Given the importance of this the findings and their practical implications on the electric power industry stakeholders will be elaborated in the following two sections.

8.2.1. Nature of public policy impacts

This research provides evidence that public policies, legislation and regulation have a crucial impact on industry structure, an individual firm business model and firm survival in the electric power industry. This impact is both directly causal -with clearly identifiable agency and intention- and evolutionary and emergent as a result of the interplay with the underlying evolutionary mechanisms. In the latter case the actions may cause unintentional results. Thus the findings of this research and the underlying theoretical constructs, causal and evolutionary mechanisms, provide a verification of North's (2005) argument that "the gap throughout history between intentions and outcomes reflects the persistent tension between the scaffolds that humans erect to understand the human landscape and the ever changing 'reality' of that landscape" (2005:ix). Indeed, the bounded rationality (Cyerth and March, 1963; Williamson, 1975) is not only a key attribute of a firm or the decision makers within a firm, but all human decision makers both in firms and in the surrounding society, in institutions and of public policy makers (Colombo and Rossini, 1997). Although there is a certain amount of causal ambiguity in the evolution of industries; some just have good luck and hit the jackpot (Dierickx and Cool, 1989), the main reason is that the causal chain or process may appear stochastic, because humans have problems to identify some of the relevant variables or events. Another characteristic of the relation between public policies and electric power industry is that it is not one-way. This coevolutionary reciprocal relationship based on mutual benefit previously identified by Ruostetsaari (1989) had an impact on the evolution of the industry. Moreover, 'human evolution'[84] (North, 2005) and the beliefs and

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[84] North (2005) argued that much of long term change in societies may be presented with a causal chain: "perceived reality → beliefs → institutions → policies → altered perceived

opportunities of the different stakeholders of the industry acted as intervening and mediating events which explains some of the firm exits from the industry.

Due to the twofold nature of the public policy effects, the bounded rationality of the decision makers both in the government and local government as well as within the firms, it is important that future public policies and subsequent measures are prepared in mutual co-operation between the government, related authorities, and the electric power industry in the form of industry associations, as well as with individual firms. Both the causal and the evolutionary effects should be thoroughly evaluated during the preparation of a law or regulation in order to limit the unintended results and avoid any corrective actions that might be required later.

In addition, this research indicates that evolutionary path dependence and asset constraints cause institutions to have both direct causal and long-term evolutionary effects on industry structure and firm survival. The asset constraints; asset mass efficiencies and time compression diseconomies are especially significant in the electric power industry due to the high capital investment requirements and long term planning horizons. Moreover, public policies and regulation restrict the use of technology through direct (such as nuclear power licensing) or secondary (such as water acts) causal mechanisms and thus cause additional asset constraints. Pineau and Hämäläinen (2000) noted that there are two major concerns with Finnish electric power market deregulation, which call for careful attention by market authorities. First, a small number of dominant players can, to certain extent rule the market. Thus the economical goal of marginal cost prices of deregulation is hardly achieved. Second, the vertical integration of electricity distribution and power generation will reduce competition in the industry. Indeed, as shown in the analysis, the evolutionary path dependence has led to market dominance by a few firms. In addition, the combined impact of evolutionary and market mechanisms, which have

reality and so on”. Moreover, he argued that human evolution “is guided by the perceptions of the players; choices – decisions are made in the light of those perceptions with the interest of producing outcomes downstream that will reduce uncertainty of the organizations – political, economic, and social – in pursuit of the goals” (2005:viii).

set the scene for vertical integration and the limitations of the regulation, have led to a situation in which there is a high risk of decreased competition in the market.

Moreover, evolutionary path dependence and asset mass efficiencies of established technologies slow down the utilization of new technologies without public policy changes and supporting public measures. Recently, climate change and the worldwide ambition to decrease the CO_2 emissions has caused the electric power industry to search for new low carbon technologies such as solar and wind power and other renewable energy technologies. Thus, in the light of path dependence, public policy makers should carefully analyze what the supporting and accelerating mechanisms needed to foster the new technologies and the preventing mechanisms for the old or unwanted ones would be (see Christensen, 2002). In addition, the secondary effects of these causal mechanisms to the survival of firms should be analyzed. Similar analysis of the existing and future technologies and the related assets is of course of crucial importance for the individual firms. Event based multi-level 'pathway analysis' supported with economic data analysis is a useful tool for individual firm management to understand the current state of a firm as an accumulation of their history. This kind of pathway analysis can act a basis for future scenario work and provides useful information for decision making when selecting technologies in which to invest.

Furthermore, this research shows that external shocks and major environmental changes intervened on the 'normal' evolution of the industry and the antecedent intended causal impacts of public policies. These environmental shocks have both direct causal consequences, but they also create a certain amount of causal ambiguity, because other – and often evolutionary mechanisms with stochastic consequences – are also simultaneously active. Therefore, a rigorous analysis should be made by the authorities to analyze the potential effects of external shocks. Although this kind of analysis would not provide full predicting power, it would serve as an important basis for possible future scenarios of the effects of environmental shocks on the electric power industry. The recent climate change debate is an outstanding example of a chain of events starting from an external shock that could have been analyzed and thus acted *a priori* rather than the need for *ex post* analysis (Sijm et al., 2006). Climate change has led to significant CO_2 emission reduction targets[85] and further to emission trade regulation in the European Union. This regulation caused windfall profits for some electric power firms. The research carried out by Kara et al. (2008) of these windfall profits and the identified counter-measures against the foreseeable negative side-impacts of the emission trade is a good example of such an ex post analysis.

8.2.2. Business model as a selection criteria

According to the analysis of the Finnish electric power industry, a firm's business model is a key selection criterion that explains firm survival in the industry. The business model of a firm is a result of both institutional coercion as well as institutional normative and mimetic isomorphism (DiMaggio and Powell, 1983). In particular, the findings of the research support the prevailing view that vertical integration as part of a firm's business model increases its viability in the long-term. However, it is notable that vertical integration also remained as an important selection criterion after deregulation. The reasons for this are threefold. First, there are transaction cost benefits to linking power generation and supply, both wholesale and retail, and electricity distribution. The second reason is based on the exploitation of certain power generation technologies. The co-generation of heat and electricity technology provides a technological and financial advantage for distribution firms, which have both electricity and central heating customers. Similarly, the back-pressure technology to generate combined heat (steam) and electricity for industrial use provides a comparable advantage for industry specific firms. The third reason is the combination of the 'obligation to deliver' statement[86] of the 1995 Electricity

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[85] The European Union has committed to decrease CO_2 emissions unilaterally by 20 percent by year 2020 percent from the 1990 level and to increase the share of renewable energy by 20 percent throughout the whole European Union by year 2020 (Vanhanen II Government Platform of Finland, April 19th, 2007).

[86] According to the 'obligation to deliver' statement of the 1995 Electricity Market Act "an electricity retailer in a major market position within the area of responsibility of a distribution system operator shall deliver electricity at reasonable prices to consumers and other users of electricity (EMA Chapter 6, 21§)". The 'reasonable price' is the standard contract price of the firm.

Market Act, the fact that the retail customer turnover has stayed at a significantly low level after deregulation and that most of the electricity was bought at a standard contract price (instead of offer price). This threefold combination provided a vertical integration benefit for the firms with own power generation and acted as a barrier of entry for sales competition.

Understanding these selection criteria and the rationale behind them is important for public policy makers, since the measures needed to debase or break them are more extensive than other actions. Likewise, more powerful and long-lasting policies and measures are needed to support development of technologies that have frail selection power, such as new emerging technologies. On the other hand these findings provide useful information for firm management and shareholders in the planning of their future business models as well as for their political agendas.

8.3. Limitations and suggestions for further studies

Despite of the theoretical contributions and valuable practical implications, there are also certain limitations to this research. The first point, the issue of keeping discipline in the complexity in a research setting and framework, is always a challenge for the researcher. Moreover, as noted by Nelson and Winter (1982): "theorists should aim to tell the truth in their theorizing, but they cannot aim to tell the whole truth. For to theorize is precisely to focus on those entities and relationships in reality that are believed to be central to the phenomenon observed — and largely ignore the rest" (1982: 134). From this perspective, in order to keep the complexity down and to be able to study the impact of institutions together with technology and market on the patterns of industry life cycle in regulated industries, I have left the impact of individuals outside of the research framework. In this research the causal impact of cognition of individuals and the subsequent beliefs were based on secondary sources (Ruostetsaari, 1986; 1998). However, I claim that the conclusions drawn from the event analysis are sufficient for the selected level of analysis in this research. Nevertheless, I suggest that further studies of the impact of cognition through the addition of individuals to the research framework would give more insight to the causal processes. This kind of analysis could also provide analytical evidence that there are no back-door paths in the causal inference that would provide alternative explanations. A firm level case study or comparative case study would be a suitable methodology for this kind of examination of cognitive effects. A second issue is that of the empirical setup of this is research which is based on the evolution of one industry in only one country. Analyzing other congruent countries, like Sweden, Norway or Spain would bring findings which would either strengthen the theoretical findings or bring new perspectives to them. Moreover, in this research I have concentrated on only one deregulated industry. A research of other deregulated industries and the comparison between them is strongly recommended to support or defuse the findings and propositions and to be able to generalize the key findings and offer a universally applicable general pattern of industry life cycle in regulated industries. In addition, the impact of the changes at the boundaries of the electric power industry from national to Nordic and further to European wide industry on firm survival is a suggested area for analysis. These kinds of studies would provide answers to questions concerning the differences in survival between firms with different counties of origin. Furthermore, they would provide answers to why the routines and assets evolved in some national settings would dominate over others.

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