Industry & Innovation
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713424563

Alternative Paths to Competitive Advantage: A Fuzzy-Set Analysis of the Origins of Large Firms

Joonas Järvinen [a]; Juha-Antti Lamberg [a]; Johan-Peter Murmann [b]; Jari Ojala [c]
[a] Department of Industrial Management, Helsinki University of Technology, Finland [b] AGSM—Australian School of Business, University of New South Wales, Australia [c] Department of History and Ethnology, University of Jyväskylä, Finland

Online publication date: 16 December 2009

To cite this Article Järvinen, Joonas, Lamberg, Juha-Antti, Murmann, Johan-Peter and Ojala, Jari(2009) 'Alternative Paths to Competitive Advantage: A Fuzzy-Set Analysis of the Origins of Large Firms', Industry & Innovation, 16: 6, 545 — 574
To link to this Article: DOI: 10.1080/13662710903371066
URL: http://dx.doi.org/10.1080/13662710903371066

Industry and Innovation,
Vol. 16, No. 6, 545–574, December 2009

Routledge
Taylor & Francis Group

Research Paper

Alternative Paths to Competitive Advantage: A Fuzzy-Set Analysis of the Origins of Large Firms

JOONAS JÄRVINEN*, JUHA-ANTTI LAMBERG*,
JOHAN-PETER MURMANN** & JARI OJALA†

**Department of Industrial Management, Helsinki University of Technology, Finland, **AGSM—Australian School of Business, University of New South Wales, Australia, †Department of History and Ethnology, University of Jyväskylä, Finland*

ABSTRACT Scholars have documented the importance of national-level factors for the competitive success of firms on a global scale. These studies typically identify multiple factors that are behind the emergence of large and successful firms in particular national clusters. However, there has been relatively little research identifying whether such factors are all collectively necessary to produce the outcome, or whether only a few of the factors in different combinations might be sufficient to generate the shift in competitive advantage manifested in the market power of large "flagship" firms. In this paper, we study the evolution of one industry across six countries in which the competitive position of national firms changed considerably during our 100-year analysis period. The results of our combined historical and fuzzy-set analyses show that an unequal distribution of resources may lead to alternative causal pathways to competitive advantage of the largest firms.

KEY WORDS: Industry evolution, competitive advantage of large firms, national clusters, history, paper industry, fuzzy-set analysis

Although strategic management research typically explains the competitive advantage of particular firms in terms of firm-specific factors, there is also a stream of literature on country-level explanations for the success of individual firms in the marketplace (Porter, 1990; Kogut, 1993; Brouthers *et al.*, 2008). Scholars have also begun to document the importance of national-level factors for the competitive success of firms in markets where competition occurs on a global rather than merely a regional scale (for an overview see Lundvall, 2007). These studies typically identify multiple factors that are behind the

Correspondence Address: Joonas Järvinen, Department of Industrial Management, Helsinki University of Technology, Helsinki, Finland. Email: joonas.jarvinen@tkk.fi

1366-2716 Print/1469-8390 Online/09/060545–30 © 2009 Taylor & Francis
DOI: 10.1080/13662710903371066

competitive advantage of firms in particular national clusters at a specific point in time (Porter, 1990; Mowery and Nelson, 1999; Lundvall *et al.*, 2002).

Most studies of particular industries over long periods of time have focused on single-country settings (for exceptions see, e.g. Dobrev *et al.*, 2001). Yet when researchers have compared long-term developments in different countries, they have demonstrated that the national background of firms had a clear impact on their performance. In the industries studied to date, winners and losers have not been distributed randomly across countries, but often cluster in one or several countries (e.g. Chandler, 1990; Murmann, 2003). What is more, the competitive advantage of nations and clusters is manifested in the emergence and evolution of large “flagship” firms that function as innovation hubs and may potentially distribute technological and business knowledge among smaller firms. This occurs especially in manufacturing industries.

Despite the increasing interest in the national background of large and successful firms, we do not possess a complete understanding of how and why national characteristics lead to the rise or fall of these dominant firms. Earlier studies have typically identified multiple factors that are behind the emergence of large firms in particular national clusters. However, there has been relatively little research identifying whether these factors are all collectively necessary to produce the outcome, or whether only a few of these factors in different combinations might be sufficient to generate the shift in competitive advantage (see Pajunen, 2008 for a fuzzy-set approach to answering these questions). This scarcity of empirical research motivated us to study the historical and causal attributes related to nation-specific competitive advantages of large firms.

In this paper, we study the evolution of one industry across six countries in which the competitive position of the national firms changed considerably during a 100-year period. Our research focuses on the evolution of paper industry firms in six European countries (Germany, UK, France, Sweden, Norway and Finland) for a number of reasons. Because of transportation costs, opportunities for clustering in the paper industry were much less than for the previously studied high-value-to-weight-ratio industries such as synthetic dyes, pharmaceuticals, microprocessors and packaged software (Mowery and Nelson, 1999). However, geographic proximity meant that the countries could export to each other, since transportation costs would not be prohibitive (cf. Krugman, 1991; Krugman and Venables, 1995). To be able to identify whether differences in the development patterns of a large country such as Germany and a small country such as Finland were driven merely by the size of the country, we compared them with countries of similar size. That is, we included Sweden and Norway as comparisons for Finland and Britain and France as comparison for Germany. Importantly, all six countries had non-trivial paper production throughout the twentieth century.

Empirically, we concentrate on explaining changes in competitive positions measured as *the relative capacity and ranking of the largest firms originating from the six countries*. This choice is based on the established theoretical view (e.g. Chandler, 1990; Geroski, 1998) supported by empirical research (Pavitt *et al.*, 1987; Camison-Zornoza *et al.*, 2004) that competitive advantage in manufacturing industries culminates in the existence and longevity of large firms. In specific historical contexts, each of the six countries was a home for large and to some extent dominant firms. We demonstrate both continuity and change in the group of the largest firms and aim for a causal explanation of how and why dominance in the group of top 20 firms changes as a function of the national characteristics of the industry.

We contribute to the evolutionary strategy literature in three specific ways. First, our extended research period allows us to show general patterns of firm and industry evolution in conjunction with the economic and political development of markets and societies. Second, our innovative combination of historical analysis and fuzzy-set logic is a methodological advance in the context of evolutionary studies. Our approach is useful in comparative settings that are potentially complex for more elaborate mathematical modeling. In particular, the method allows us to integrate quantitative measures with theoretical and substantive insights of the studied phenomenon. By relying on sufficient and necessary causation, the method also enables us to study different configurations of factors that potentially lead into the same outcome, but which are not enabled by mainstream regression analysis techniques.[1] Third, our results demonstrate the ephemeral nature of competitive advantage of large firms and offer important implications for policy makers interested in the emergence of new successful firms.

Theoretical Background

The emergence of large and successful firms is one of the key questions in strategic management. The importance of this question is related to findings that demonstrate that large firms have a higher survival rate than smaller firms (Barnett *et al.*, 1994; Klepper, 1996); they function as innovation hubs in network-based clusters (Dhanaraj and Parkhe, 2006); and have the ability to produce important process innovations that raise the overall effectiveness of a certain industry (Pavitt *et al.*, 1987; Klepper, 1996).[2] To explain the sources of competitive success is a more complicated matter. The view that firm-based resources and capabilities explain firm growth and performance outcomes (e.g. growth and profitability or decline and loss) is especially dominant in the literature based on resources (Barney, 1991) and dynamic capabilities (Teece *et al.*, 1997). From this perspective, firm-level features explain performance.

A related perspective in business history locates performance in the hands of managers. Historians working on organizational decline (e.g. Chandler, 1962, 1977, 1990; Galambos, 1988; Cassis, 1997) see these events as failures to change organizational arrangement to meet the demands of the environment. Similarly, when new organizations arise they are interpreted as providing organizational solutions to needed coordination of economic activity. Before the rise of the resource and capability-based views of strategic management, scholars typically reduced the firm-level competitive advantage to the structural characteristics of the specific industry. In the dynamic version of industrial organization, researchers (e.g. Klepper, 1996) see that the market and institutional environment "decides" on the survival opportunities of individual firms. The empirical research following Klepper's theoretical framework (1996, 2002) has demonstrated that the

---

[1] Although statistical cluster analysis allows studying the effects of different configurations on an outcome of interest, it has a number of known limitations (discussed later in the paper). Fuzzy-set analysis is, however, able to overcome these at least partly (see, e.g. Fiss, 2007; Pajunen, 2008).

[2] Many scholars also emphasize the importance of small firms in innovation networks and cluster competitiveness. This view has its obvious merits, yet we see that in process industries it is both legitimate and constructive to locate cluster competitiveness in the existence of large firms. More discussion in Patel and Pavitt (1997) and Camison-Zornoza *et al.* (2004).

Table 1. Antecedents related to competitive advantage of industrial clusters by some recent studies

Article/book	Research design/methods	Main antecedents
Porter (1990)	Theoretical/empirical multiple case study	Factor conditions Demand conditions Related and supporting industries Firm strategy, structure and rivalry Government and chance events
Healey and Dunham (1994)	Empirical single case study	Antecedents by Porter (1990)
Clancy *et al.* (2001)	Empirical multiple case study	Antecedents by Porter (1990)
Lai and Shyu (2005)	Empirical two case study	Antecedents by Porter (1990)
Blundel and Thatcher (2005)	Empirical multiple case study	Antecedents by Porter (1990) Collective entrepreneurship by Best (2001)
Walker and Minnitt (2006)	Empirical single case study	Antecedents by Porter (1990)
Mowery and Nelson (1999)	Empirical multiple case study	Resources Institutions Markets Technology
Wilk and Fernsterseifer (2003)	Empirical single case study	Cluster-specific resources that are, for example, path dependent, immobile, inimitable and complex in nature
Sölvell *et al.* (2003)	Empirical multiple case study	Cluster initiatives General business environment (national legacy and culture, geographical position, general institutions and legal framework, and macroeconomic environment) The microeconomic business environment (Porter, 1990) Macro- and microeconomic policy
John and Pouder (2006)	Theoretical/two example cases	Linkage to global markets Accumulated entrepreneurial experience Regional networks Sustaining advantage over time
Lawson and Lorenz (1999)	Theoretical	Tacit knowledge
Pinch *et al.* (2003)	Theoretical	Firm and cluster-level component knowledge Firm and cluster-level architectural knowledge
Morosini (2004)	Theoretical	Global scope of competition High degree of knowledge integration
Tallman *et al.* (2004)	Theoretical	Firm and cluster-level component knowledge Firm and cluster-level architectural knowledge
Lin *et al.* (2006)	Theoretical/literature review	Close proximity to professional human resources and components **Productivity:** Close proximity to information Complementary relationships among industries and complete infrastructure Competitive pressure

Table 1. Continued

Article/book	Research design/methods	Main antecedents
		Innovation capability: Gives firms access to new components Reduces experimental costs Make differentiation as the motivator of innovation **New enterprise formation:** Ease of obtaining market information Low entry barriers

size and age of firms and their R&D investments in process innovations enhance survival probability, whereas novelty and emphasis on product innovations risk organizational survival (for an alternative argument see McGahan and Silverman, 2001). Evolutionary scholars, furthermore, have suggested that evolutionary processes are characterized (a) by a large turnover of firms (total number of entries – exits over time) and (b) this process is needed for the selection of successful firms. This hypothesis has been verified in a number of empirical contexts.

In a related vein, many scholars assume that it is the characteristics of the institutional environment which primarily explain the emergence and destruction of business organizations. In our case this means the emergence and longevity of large firms. For example, research in new political economics (North, 1990) sees institutions as motivating firms to create capabilities for political rent-seeking at the expense of their long-term business strategies. In the same spirit, authorities in national innovation systems literature (e.g. Nelson and Winter, 1982; Nelson, 1993) have found that the innovation environment may dramatically affect the distribution of large firms among different countries. This argument is especially influential in the literature that focuses on the competitive advantages of industrial clusters. Table 1 lists some of the most recent contributions to this literature.

Porter's widely known (and implemented) "diamond" model (1990) specifies four determinants of competitive advantage (factor conditions; demand conditions; related and supporting industries; and firm strategy, structure and rivalry). Porter's work has been followed by several studies. The case studies either assess the competitive advantage of some cluster/clusters (e.g. Healey and Dunham, 1994; Lai and Shyu, 2005; Walker and Minnitt, 2006) by employing the diamond framework, or else they criticize it (e.g. Clancy *et al.*, 2001; Blundel and Thatcher, 2005). Other literature in this domain has been primarily theoretical, and offers a variety of explanations for the competitive advantage of industrial clusters. For instance, Wilk and Fernsterseifer (2003) suggest that the cluster-level competitive advantage rests on its specific resources, Lawson and Lorenz (1999), Pinch *et al.* (2003) and Tallman *et al.* (2004) focus their attention on the role of different types of knowledge, Morosini (2004) proposes that competitive advantage can be achieved by a global scope of competition and a high degree of knowledge integration. Lin *et al.* (2006) argue that industrial clusters improve their competitiveness by increasing inter-organizational and industrial productivity, by advancing innovation capability, and by stimulating new enterprise formation.

To summarize the above review, earlier research has identified a considerable number of antecedents that may be associated with cluster-level competitive advantage as materialized in the existence of large "flagship" firms. Many of these antecedents are rather specific. However, we may identify three broader themes that will guide our historical account. These are the *economics of an industry* (i.e. how value is generated in an industry); the *organization of markets* (how value creation activities are organized in different countries); and the *innovation environment and technological knowledge* (to what extent the surrounding innovation environment affects the accumulation of technological knowledge). So far, very little empirical research has systematically studied whether the antecedents are always the same across industries or whether they are jointly necessary or sufficient for clustering to occur. From this starting point, we next focus on the evolution of one specific evolutionary process in the context of the European paper industry.

A Short History of the Paper Industry in Europe

The first paper production plants in the countries analyzed in this study were established between 1320 (France and Germany) and 1706 (Norway) (see Table 2). Before the nineteenth century paper was hand-made in small-scale manufacturing units, using rags as raw materials. Industrial scale paper production emerged during the early nineteenth century. In the following, we aim to give a historical analysis of this period of mechanization and industrialization of paper production, in the constraints of institutions, markets and technological changes. Finally, we conclude with an analysis of changes in industry dominance both globally and among the case countries.

From an evolutionary and strategic perspective, the global paper industry became increasingly competitive from the late nineteenth century onwards. This development is documented in Table 3. Following almost exactly Klepper's shakeout model (1996), at first the number of entries increased steadily until the 1930s. After that period the number of exits has exceeded the number of entries, leading to an increasing concentration rate and finally to almost no new entries. The population level decline after the 1930s has been dramatic. Whereas the total number of companies manufacturing paper and pulp in the six case countries was over 1500 in 1938, it had decreased to 353 by 2000.[3] Most recently, the industry has been characterized by a global rivalry between a relatively small number of dominant firms (Lamberg and Ojala, 2006).

An important notion concerning the evolution of the population of firms in different countries is the embedding in institutional contexts characterized by severe and sometimes dramatic changes. That is, external shocks in terms of two world wars, the division and reunion of the two Germanys, the rise and fall of communist regimes, and the emergence of European Union and various international arrangements for world trade have all had a

[3] Simultaneously, the period from 1800 to 2000 witnessed a significant technological shift from hand-made to mechanical manufacturing. In Germany, for example, there were over 1000 paper-producing companies in 1847; most of them were small manufacturers who produced hand-made paper (Krawany, 1910).

Table 2. The beginning of paper manufacturing and the first paper machines in the case countries

	Finland	France	Germany	Norway	Sweden	UK	Average
Beginning of paper production (year)	1667	1320	1320	1706	1550	1490	1509
First modern paper machine (year)	1842	1816	1819	1838	1831	1803	1825

Sources: Krawany (1910), Salzman (1911), Rjestoff (1913) and Munsell (1980).

significant impact on paper production in the case countries. In this respect Germany especially is a case that cannot be understood without taking into account these severe changes in institutional constraints (e.g. Lamberg and Laurila, 2005).

From a purely economic point of view, economic growth and the consumption of paper have correlated strongly. Increased literacy, expanding populations, and enhanced printing and press technologies created markets for paper products during the nineteenth century. During the twentieth century, paper consumption per capita increased even more (Coleman, 1958: 208–209; Diesen, 1998: 65). The six countries selected in our study reflect both supply and demand factors in the industry. The large countries (Germany, France and Britain) had significant domestic consumption that could also be satisfied with imports. However, the small Nordic countries (Finland, Sweden and Norway) had only limited domestic markets, yet significant raw material resources that enabled the growth of their forest industries. The share of total GDP in the case countries is reported in Table 4, showing that the three large countries comprised 95 per cent of the combined GDP of the case countries in 1820 and around 89 per cent in 2000. These figures correlate strongly with the population shares: in 1820 about 94 per cent and in 2000 about 91 per cent of the combined population of all six case countries belonged to the three large countries. Therefore, the large countries also provided larger markets for paper industry products. Table 4 also shows economic growth in all countries in general, and especially, the rapid growth in the Nordic countries in particular.

On the supply side, the availability of raw materials is one of the most important determinants. Ever since timber emerged as the most important raw material in the

Table 3. Industry evolution: number of paper-producing companies in case countries 1800–2000

	Finland	France	Germany	Norway	Sweden	UK	Sum
1800	2	n/a	500	2	7	434	n/a
1850	4	n/a	857	2	7	452	n/a
1875	10	524	423	16	20	296	1289
1908	22	321	517	25	56	301	1242
1938	34	297	856	55	78	217	1537
1950	26	306	276	60	87	202	957
1974	26	205	220	40	42	103	636
2000	10	79	166	15	25	58	353

Sources: Dykes Spicer (1907), Krawany (1910), Salzman (1911), Coleman (1958), UNECE (1964–2006) and the Paper Industry Database compiled by the authors (at http://research.jyu.fi/orgevolution/datasets.shtml).

Table 4. Share of total GDP of the case countries combined with GDP in cross-cutting years (per cent)

	Finland	France	Germany	Norway	Sweden	UK	Sum
1820	0.9	34.3	26.0	0.8	3.0	35.1	100.0
1850	0.8	32.8	27.2	0.8	2.5	35.8	100.0
1875	0.8	28.6	29.1	0.9	2.7	38.0	100.0
1913	1.0	21.6	37.1	0.9	2.9	36.5	100.0
1938	1.5	21.2	38.8	1.4	3.4	33.7	100.0
1950	1.9	24.1	29.0	1.9	5.2	38.0	100.0
1974	2.1	27.8	37.6	1.8	4.5	26.3	100.0
2000	2.3	28.6	35.3	2.6	4.2	27.1	100.0

Sources: Maddison (2001); Groningen database (http://www.ggdc.net/dseries/).

paper industry, the availability of forests has been an important factor for the industries in each country. The paper production procedure was patented in 1854. Wood-based paper production gave an advantage to countries with considerable wood resources (Norway, Finland, Sweden, and to some extent Germany and France). In Britain, other raw materials were more widely used up to the 1870s, when wood pulp, mainly imported from Norway, Sweden and Canada, slowly began to replace the previous raw materials. The wood resource base of the case countries is reported in Table 5. In addition to wood, energy is also an important supply-side factor. The Nordic countries had favorable hydro energy resources, with the first paper mills all situated on or nearby rapids.

Today's paper manufacturing technology has gradually developed over the past 200 years. The modern paper machine ("Fourdnier") was invented in France in 1797, and the first machine was started in 1803 in the UK. During the first half of the nineteenth century the Fourdnier machines were introduced to all six countries; in Germany, for example, 20 paper machines were running already in 1830 (Dykes Spicer, 1907: 58–64; Krawany, 1910; Salzman, 1911; Coleman, 1958: 179–226; Toivanen, 2004).

The operational principle of a paper machine, whether built in 1805, 1905 or 2005, is basically the same. There have been, however, a number of improvements which have led to an enormous growth in the size and the capacity of the machines. The average paper machine of 1805 was 135 centimeters wide and produced 11 meters of paper per minute, annually some 300 tons. The 1905 average machine was 315 centimeters wide, produced 60 meters of paper per minute and 3000 tons per year. The modern paper machine of 2005 was on average 930 centimeters wide, produced 1800 meters of paper per minute and 400,000 tons per year (Dykes Spicer, 1907: 44, 47, 69; Lund, 1999).[4] The technological history of paper making, therefore, is a story of increasing scale. What is more, technological change has not decelerated in the 200 years since the introduction of the first paper machine. The annual output of new machines has increased exponentially since the beginning of the industry, because engineers have introduced very sophisticated new technologies in the parts that

[4] The illustrative 2005 paper machine is the one built by UPM-Kymmene in Rauma, Finland (PK8) in 1998.

Table 5. Forest area in the case countries (1000 hectares)

	Finland	France	Germany	Norway	Sweden	UK	Together
1938	21,625	10,321	7042	4951	20,895	1254	66,088
1950	21,900	11,131	8754	5300	20,950	1525	69,560
1974	22,520	13,181	9880	5900	22,204	2002	75,687
2000	23,046	14,681	10,526	6754	21,273	2791	79,071

Sources: Gold (2003) and FAO databases (http://www.fao.org/documents/).

make up a paper machine. Figure 1 illustrates the development of paper machine technology from 1800 to 2000.

The chemical pulping process, invented in 1867 (sulphite) and 1884 (sulphate), was the next major technological step in paper making (Dykes Spicer, 1907: 18–23). Chemical pulp made it possible to gain a scale advantage. Minerals and chemicals have increasingly played an important role in paper making since the late nineteenth century. For example, China clay was added to pulp already in the beginning of the nineteenth century to give body and weight to finished sheets. The use of clay became even more pronounced when wood was introduced as a raw material. Chemical processes for bleaching and coloring paper were also introduced during the nineteenth century, and have been developed significantly during the past 150 years. Among other significant technological leaps during the latter part of the twentieth century have been the development of coated paper grades, the use of recycled fiber and the creation of different “wood-free” paper grades. By the mid-1990s the total raw material supply in the world needed for paper making consisted of 55 per cent wood-based raw materials, 30 per cent recycled fiber, 12 per cent minerals and chemicals, and 3 per cent of non-wood fiber (Dykes Spicer, 1907: 72–90; Diesen, 1998: 30, 63–64; Kettunen, 2002).

Thus, by the turn of the nineteenth and twentieth centuries, all the major innovations of paper making as known today had been introduced. Nonetheless, twentieth-century paper making added integrated mechanization of the production process; automation and computerization of the production control systems; integrated units, improved productivity through “giant” machines, environmental control that induced raw material and energy-saving production, and new raw materials (Dykes Spicer, 1907: 54; Ojala *et al.*, 2006: 262–263). As a consequence of this continuous stream of process innovations, the shakeout period has been less drastic and considerably longer than in some other industries like car manufacturing (cf. Klepper, 1996; Christensen *et al.*, 1998).

Due to the large production facilities, the paper and pulp industry is among the most capital intensive lines of business. To simplify, one can argue that the value added of the production increased in hand with the quality and technology intensity of the products. On the low-tech and low-value side of the product spectrum lie newsprint and uncoated wood-free grades (such as WF), and at the other end of the spectrum lie high-tech and high-value coated paper grades such as LWC, MWC and WFC[5] (Häggblom, 1999; Hazley, 2000).

[5] WF = uncoated wood free; LWC = light weight coated; MVC = medium weight coated; WFC = coated wood free.

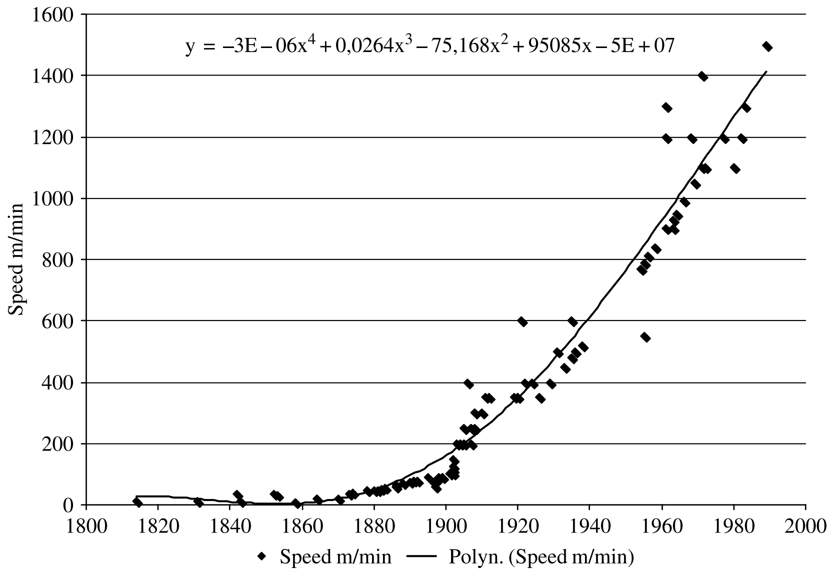

Figure 1. Average speed of paper machines, 1800–2000; meters/minute. *Source:* Lund (1999); figure layout and modeling by Mikko Lauerma.

Especially Nordic companies have focused on the production of high-tech and high-value grades in their investments during the 1980s and 1990s. As Chandler stated, in the paper industry "the technology of production was not complex enough to provide an incentive for a substantial investment in research and development". Therefore, right after the Second World War, the US paper industry had one of the lowest research intensities of any line of large corporation business (Chandler, 1990: 113).

Changes in Industry Dominance

From a global perspective, the six case countries have lost their combined relative share in paper production. This is illustrated in Table 6. While in 1875 the case countries produced roughly 60 per cent of the world paper production, this share had dropped to about one-third

Table 6. Percentage share of global paper production: all case countries, the Nordic countries and the USA, 1875–2006

	All case countries	Nordic countries	USA
1875	60	5	18
1908	42	6	37
1964	21	7	59
1974	24	11	47
2006	31	13	39

Sources: Salzman (1911: 61), UNECE (1964–2006), Fasting (1968) and Munsell (1980: 230).

in 2006. Especially the large case countries seem to have lost their relative importance, while the small Nordic countries have increased their relative share of production. In 1875 Germany and Britain were the largest paper producers in the world, with a 20 per cent share each. In global competition the rapid expansion of the US paper production is the single most important determinant for the change—its share raised from less than one-fifth in 1875 to over half by the 1960s (Salzman, 1911: 61; UNECE, 1964–2006; Fasting, 1968; Munsell, 1980: 230).

There was also a clear shift in industry dominance among the case countries from the larger countries (Germany, France and Britain) to the Nordic countries (Finland, Norway, Sweden) during the period from the 1870s to the late twentieth century. This change is reported in Table 7. In 1875 the Nordic countries produced about 8 per cent of the total paper production of the case countries; in 1974 this share had reached almost 49 per cent. Especially the share of Finnish and Swedish companies was remarkable, though Sweden (as well as Norway) saw a decline in its position by the turn of the millennium. Of the large countries France and Britain were, relatively speaking, the most formidable losers. Germany is a special case, as for the 1950 and 1974 figures only the share of West Germany has been noted; furthermore, the former East German paper industry faced severe difficulties in the 1990s after the reunion of the country.

As can be seen in Table 8, however, there was a significant difference in the size of the companies already in the late nineteenth century. Finnish and Norwegian companies were larger as an average already at the turn of the twentieth century. Finnish companies kept this position throughout the study period. On the other hand, when we focus on the largest companies across the six countries we see that every country had at least one company among the 20 largest companies. Table 9 shows the number of companies in the top 20 by country of origin.

Change in industry dominance can also be seen in the different speed of technological change across the six countries. Table 10 reports the average width of machines as a proxy for the technological progress in the national industries. Wider machines correlate with the production capacity; furthermore, the technological development in the paper industry has been closely related to the growth of the machinery. Also, Table 10 shows that, on average, the Nordic companies have had larger machines than the other countries in the sample. This development became even more evident during the latter part of the twentieth century, when Finnish paper machines, for example, were twice or even three times the size of the machines on average in the other case countries.

Table 7. The case countries' share of combined paper production (per cent)

	Finland	France	Germany	Norway	Sweden	UK	Together
1875	5.0	25.0	38.3	1.7	1.7	28.3	100.0
1913	5.1	15.5	43.9	7.3	4.2	23.9	100.0
1938	8.1	12.8	37.5	8.7	3.7	29.2	100.0
1950	9.7	16.6	19.8	14.9	6.1	32.9	100.0
1974	21.5	8.2	25.4	5.6	21.5	17.9	100.0
2000	21.9	16.2	29.4	3.7	17.5	11.2	100.0

Sources: See Table 2.

Table 8. Index of average paper production per company (UK 1875 equals 1)

	Finland	France	Germany	Norway	Sweden	UK	Together average
1875	5.2	0.5	1.0	1.1	0.9	1.0	1.6
1908	18.2	3.8	6.7	23.0	5.9	6.3	10.6
1938	37.9	6.9	7.0	25.0	7.6	21.4	17.6
1950	51.6	7.5	9.9	34.3	9.6	22.5	22.6
1974	368.5	17.9	51.5	62.7	228.1	77.8	134.4
2000	2351.9	220.5	190.0	267.1	752.6	207.3	664.9

Sources: See Table 2.

Table 9. Country of origin of the 20 largest companies

	Finland	France	Germany	Norway	Sweden	UK	Together
1910	2	3	8	1	1	5	20
1938	4	1	6	2	4	3	20
1950	5	5	2	0	6	2	20
1974	4	4	3	1	5	3	20
2000	5	4	3	1	6	1	20

Source: The Paper Industry Database compiled by the authors.

Table 10. Average width of the paper machines in the case countries (cm)

	Finland	France	Germany	Norway	Sweden	UK	Together average
1910	634	317	378	412	721	457	487
1938	399	399	418	554	933	649	559
1950	1112	386	394	595	965	746	700
1974	2251	523	643	884	1565	1007	1146
2000	6533	560	706	1156	1988	769	1952

Table 11 summarizes the major findings of our historical account. Our historical description of the past 200 years of the paper and pulp industry brought into focus that (a) each of the six countries has brought forth large and potentially successful companies; (b) considerable changes in relative competitive position took place; and (c) a variety of factors seems to have led to the rise and fall of paper industry companies across the six countries. To develop a deeper causal understanding of the developments in the six national paper and pulp industries, we will now integrate our insight with those emerging from the theoretical literature and then run analyses to specify how these causal factors individually or jointly produced the changes in position of large firms in the six different countries.

Table 11. Major phases of the development of the paper industry in the case countries

	Overall development of paper industry	Paper industry in case countries
1800–75	Early mechanization of paper production; emergence of wood as the main raw material for European paper making.	Slow adaptation of paper machine—bulk of production still hand-made. Large number of individual (small) paper-producing companies. UK and Germany world leaders in paper making.
1875–1910	Rapid growth of industrial paper making; declining role of hand-made paper. Advanced chemical pulping. Emergence of the USA as the main paper-producing country.	Relative share of Nordic countries in paper producing rises; France loosing its former share.
1910–74	Significant institutional changes affecting industries; rapidly growing markets, new paper products.	External shocks: two world wars, Europe divided, European integration—all affecting the case countries' paper making. Large countries losing shares.
1974–2006	Emerging globalization; multinational companies entering the paper industry; automatization of production; consolidation. Western markets maturing.	Consolidation of paper companies in all countries. Internationalization of production. Economies of scale both in terms of technology and the size of the companies, especially in Finnish and Swedish multinational paper industry companies.

Research Problem

Examining the history of the paper and pulp industry through the lens of the existing theoretical literature, we found broad themes that may potentially explain changes in the competitive advantage of large firms over time. Porter's diamond model (1990) and related work in the cluster literature offers insights to understand the distribution of large firms in a particular timeframe. However, our historical account demonstrates considerable change in the competitiveness of large firms over time. Also, very different types of national backgrounds have contextualized the rise (and fall) of large firms over the 100 years studied. When we combined the identified themes from the theoretical literature with the context-specific information from our historical account we ended up with seven different factors that we will use as starting points in our set-based analysis. In the following, the seven factors are categorized under the three identified theoretical themes.

First, *economic* factors are related to firm exogenous issues that define the market and production potential of individual companies. This line of thought goes back to the classic works of economics and is clearly the starting point in the more recent industrial organization and cluster literature. Also, the literature which focuses on the political economy of foreign trade is relevant here, suggesting that export-oriented industries may benefit from societal support especially if their economic impact is high (see, e.g. Krueger, 1974; Brock *et al.*, 1989). Taking into consideration the context-specific differences and historical circumstances across the six case countries, we can assume that the following economic factors affect the level of competitive advantage:

(1) availability of key raw material resources for pulp and paper industry firms (i.e. the supply of wood);
(2) size of the domestic market;
(3) trade balance related to paper imports and exports.

The second set of factors refers to the *organization of markets* (Williamson, 1975; North, 1990). The evolutionary literature, for example, assumes that large turnover is needed to create firms that are well-adapted to changing environments. However, our historical account shows that many countries that have nurtured large companies are actually characterized by small populations and fewer entries and exits of companies. A possible explanation is that some of the countries have allowed business practices that have buffered the existing firms from competition (Barnett *et al.*, 1994). We know, for example, that the six countries varied in their policies and practices towards cartels. Especially in Finland the large companies in practice outsourced their marketing and selling activities to a national cartel (i.e. the Finnpap sales association), which then represented the entire Finnish production capacity outside Finnish borders. Thus, the following market characteristics are expected to explain the level of competitive advantage of large firms:

(4) level of cartelization;
(5) evolutionary change.

Finally, one stream of literature focuses on the innovation environment and *technological knowledge* as potential explanations of competitive advantage. As our historical account exhibited, the technological development has been gradual but intensive during the last 200 years. What is more, the variation between different national firm populations has been large. Partly, this reflects the structure of the population (e.g. hundreds of small firms in Germany which very rarely invest in the most modern technology), but also the quality and amount of engineering knowledge in specific countries and firms. Previous research has identified national academic strength in particular disciplines as being an important factor in global competition (Nelson, 1993; Murmann, 2003). Academic organization and strength developed in different ways across the six countries. Only Finland and Sweden created special disciplines in paper engineering; in Germany basic sciences such as chemistry played a more important role in R&D activities. For these reasons we assume that two more factors, both related to technological knowledge also affect the level of competitive advantage:

(6) technological change;
(7) national academic strength.

Method and Data

Data

As is typical in evolutionary and ecological research, our main data sources are historical statistics and industry-specific trade directories. Before the quantitative work, we engaged in intensive historical work, collecting a vast number of company histories, magazine articles, industry-specific handbooks and extensive interview data. Overall, this first stage of data collection created an understanding of the general patterns of industry evolution and enhanced our ability to meaningfully collect and interpret quantitative information.

After the quantitative historical work, we started to build an international paper industry database. This database includes information on (a) all paper industry companies in the world, although (b) with more detail on the six case countries. Simultaneously, we collected other material that helped to confirm and complement the main database. In the building of the database, we used *Phillips' Paper Trade Directory of the World* as the primary source (Phillips, 1910, 1950, 1971, 1974, 2000). To complement missing information, we also used the Birkner European Paper Industry directory (especially for Germany, France and the UK) (Birkner, 1900–1975), and for the Nordic countries, *Nordisk Papperskalender* together with some national industry directories (Osakeyhtiöt, 1937–1973; Landberg *et al*., 1950; Lyrholm, 1950).[6] Furthermore, we complemented and verified company-specific figures for 1974 and 2000 from *Pulp and Paper International Magazine*, the Paperloop website, company annual reports, the websites of individual companies, and company histories and other relevant literature. Finally, we interviewed industry specialists to verify our interpretations and overall patterns in our analysis. Thus, the data and our interpretations were verified in an iterative manner. Altogether, our data collection phase lasted over 10 years, starting in 1998 and ending in 2008.

Following established practice in evolutionary research, we defined company entry and exit as the founding years and dates of closure. In the cases of missing information, we followed Dobrev *et al.* (2001) and identified entry and exit years using existence and non-existence in the database as a proxy for founding or disbanding. Namely, if the exact dates were not available, the firms' previous or subsequent existence in the database was the determinant for entries and exits. If the company did not exist in the previous cross-cutting year, it was defined as an "entry" for the named year. Similarly, if the company no longer existed in the following cross-cutting year, it was defined as an "exit".

For the identification of the companies between the cross-cutting years, we used industry directories, company histories and other relevant material as sources. Primarily, the company name was used as the key to identify the firms. However, as the names have changed over time, the addresses of the companies were also used in the identification process. Furthermore, for many companies, the exit years can be determined from literature and from other sources (e.g. industry newspapers), for example, when the company was acquired or when a certain mill was closed.

To measure the set of antecedents, we used statistical data. Especially the Food and Agriculture Organization (FAO) of the United Nations (UN) offers a rich source of information, including not only statistics but also various kinds of research reports and analyses. The focus in these FAO reports is usually forest resources, mainly on a national-level macro scale (Diouf, 2007; see, e.g. Gold, 2003; Perlis, 2007). The national statistics are also informative for the post-Second World War era with regards to most of the questions

[6] Information on Swedish companies can be found at: http://www.svar.ra.se/ (Aktiebolagsdatabas—listed company database).

posed in this study.[7] The information on the membership of paper engineers in the Technical Association of the Pulp and Paper Industry (Tappi) was derived from the Tappi Yearbooks and directly from Tappi (1932–1972).

When analyzing the pre-Second World War era, and especially the nineteenth century or even earlier periods of time, the statistical data is partly problematic. For general economic trends (GDP, Population) the Groningen Growth and Development Centre database, together with data compiled by Angus Maddison, were used (Maddison, 2001).[8] National (historical) statistics were also used (Statistik, 1972; Statistikk, 1978, 1995; Vattula, 1983). These, however, are not especially detailed, with the exception of the Nordic countries, when dealing with paper and pulp industries. Therefore, a number of more specific studies were consulted to derive the data on the paper industry, the economy in general and even on individual companies (Dykes Spicer, 1907; Krawany, 1910; Salzman, 1911; Rjestoff, 1913; Coleman, 1958; Fasting, 1968; Munsell, 1980; Moen, 1998).

Fuzzy-Set Qualitative Comparative Analysis

To analyze the causal conditions leading to competitive advantage of large firms, we employ set-theoretical methodology (cf. Fiss, 2007; Pajunen, 2008) in the form of fuzzy-set qualitative comparative analysis (fsQCA) (Ragin, 2000, 2007). In general, the method can be described as bridging the mainstream quantitative and qualitative research techniques by combining quantitative measures and qualitative inference based on substantive and theoretical knowledge. In the following, we briefly describe the method; additionally, we discuss how the method differs from conventional regression analysis.

fsQCA builds on the diversity-oriented research approach that considers populations as being composed of many different types of cases, or more specifically as different configurations of aspects and features termed causal conditions (Ragin, 2000). The central idea is set membership: a set membership score for every studied case in every set, defined by the studied causal conditions, is assigned (e.g. a country's membership score in the set of countries with high level of forest resources). The key set-theoretical relation then becomes that of the subset relation: if several causally relevant conditions uniformly exhibit the same outcome, then these cases constitute a subset of instances of the outcome (Ragin, 2000, 2007).

With fuzzy sets, set membership is not restricted to binary values. On the contrary, a set membership may be defined using membership scores ranging from ordinal up to continuous values between zero and one. However, as fuzzy-set analysis is not interested in how cases differ from one another in quantifiable magnitude of open-ended variation, but the degree to which different cases belong to a set, it becomes necessary to establish criteria for the set membership scores for the causal conditions, and especially for how to distinguish between relevant and irrelevant variations (cf. Pajunen, 2008). This is accomplished by

[7] On Finnish statistics see: http://www.stat.fi/; on Swedish statistics: http://www.scb.se/; on Norwegian statistics: http://www.ssb.no/; on German statistics: http://www.destatis.de/; on French statistics: http://www.statistique-publique.fr/; on British statistics: http://www.statistics.gov.uk/. See also Eurostat (http://epp.eurostat.ec.europa.eu) and OECD (http://www.oecd.org/statsportal/).

[8] See http://www.ggdc.net/dseries/—furthermore, a collection of Nordic historical national accounts can be found at: http://avos3.nhh.no/forskning/nnb/

specifying values particularly for the following three important qualitative "anchor points": full set membership (i.e. a set membership score of 1), partial set membership (especially a score of 0.5) and exclusion from the set (i.e. a set membership score of 0). Employing substantive and theoretical knowledge related to the studied phenomenon (Ragin, 2000) is essential at this point.

Thus, the difference between fuzzy-set membership scores and conventional statistical variables, which are measured on nominal, ordinal, interval or ratio scales and intended to be objective and comprehensible only relative to other possible values of the same variable, is considerable. In particular, this difference becomes evident in situations when the studied construct is difficult to measure and quantify: although constructing a valid conventional statistical variable may be impossible, creating a fuzzy-set measure, based on substantive and theoretical knowledge of the situation, is often possible.

As regards the nature of the causal inference in the fsQCA, this relies upon the set-theoretic definitions of necessity and sufficiency (Ragin, 2000). For necessity, the outcome is a subset of the causal factor. An outcome Y is considered a subset of the causal condition X if the following holds for the fuzzy-membership scores of conditions X and Y for all cases:

$$X \geq Y.$$

Necessity implies, then, that the membership degree of a case in a causal factor should be associated with a smaller membership value in the outcome. For sufficiency, the causal factor is a subset of the outcome. In particular, X is a sufficient cause for Y, if the following holds for all cases:

$$X \leq Y.$$

Sufficiency implies, then, that the membership degree of a case in the causal factor is a subset of the outcome.

Again, we can detect a contrast between conventional regression analysis and fuzzy-set analysis: whereas analysts using regression analysis often assume linear causation and attempt to estimate the average effect of a given variable net of all other variables, in fuzzy-set analysis, researchers assume necessary and sufficient causation, including combinations of jointly sufficient causes. Thus, the method enables the identification of different combinations of causal factors (i.e. configurations) which lead into an outcome of interest.[9] Additionally, because the hypotheses related to necessary and sufficient causation are fundamentally bivariate in nature (see Katz *et al.*, 2005), by using fuzzy-set

[9] Although statistical cluster analysis allows studying the effects of different configurations of variables on an outcome of interest, it also has its well-known limitations (see, e.g. Fiss, 2007). For example, cluster analysis tends to treat each configuration as a black box insofar as only differences between constellations of variables can be detected (i.e. the analysis does not extend to the contribution of individual elements to the whole or to an understanding of just how these elements combine to achieve the outcome); cluster analysis methods have high reliance on research judgment (e.g. the choice of a stopping rule); and the cluster solutions for configurations are often highly unstable and their interpretation is frequently difficult. By employing fuzzy-set logic, however, we are able to overcome these problems. This is because fuzzy-set logic relies more on qualitative reasoning based on substantive and theoretical knowledge, and its causation is based on necessity and sufficiency.

analysis it is possible to achieve statistically significant results even with small samples (as we have), in contrast to regression analysis, which usually requires far larger samples.

Necessary and sufficient causation can be assessed using a deterministic, veristic or probabilistic approach. When using a probabilistic approach, while the data may not be fully consistent with necessary or sufficient causation in deterministic terms, the research may conclude that the data are consistent, for example, with usually necessary or usually sufficient causation (Ragin, 2000; Pennings, 2003; Katz *et al.*, 2005).

Presently, there are two algorithms for performing fuzzy-set qualitative comparative analysis. The first is the inclusion algorithm presented in Ragin (2000) and later applied in several studies (see Kogut *et al.*, 2004; Katz *et al.*, 2005; Pajunen, 2008). The second is the truth-table algorithm introduced by Ragin (2006, 2007). As the new analytic strategy is, according to Ragin (2007), superior in several aspects to the inclusion algorithm, we employ it as an analytical method. Consequently, we primarily study sufficient causation.

The analysis based on the truth-table algorithm proceeds as follows (see Ragin, 2007 for details). Given that k causal conditions are selected for analysis, a multidimensional vector space constructed from fuzzy sets has 2^k corners. These corners represent the causal arguments that can be constructed from a given set of causal conditions. A case is considered to be a member of a corner or configuration when it has a fuzzy-membership score of more than 0.5 in the focal corner.

Given these premises, a truth table can be constructed. The truth table is constructed by listing all corners of the vector space as rows of the table. The table is then supplemented with two key measures that provide information for the researcher to assess whether a configuration can be considered relevant, and when a configuration is relevant, whether the configuration is a sufficient cause or not for the focal outcome. First, to assess the first condition, a column of membership frequencies, that is, the number of cases that are members of a corner, is constructed. According to Ragin (2007), the researcher should select a threshold that distinguishes between configurations that exhibit adequate empirical evidence and those that do not. For quite a small number of cases, the appropriate threshold is one. The configurations that have membership frequencies below the threshold, called logical remainders, are considered to lack adequate empirical evidence and are removed from the table.

Second, to evaluate each combination's consistency with the set-theoretic relation in question, the consistency measure is created. This is defined as follows (Ragin, 2006, 2007):

$$\mathit{Consistency}(\mathbf{X}_i \leq \mathbf{Y}_i) = \frac{\sum_{i=1}^{N} \min(\mathbf{X}_i, \mathbf{Y}_i)}{\sum_{i=1}^{N} \mathbf{X}_i}$$

where $\mathbf{X}_i$ represent membership scores in a combination of conditions and $\mathbf{Y}_i$ represent membership scores in the outcome. The value of the score ranges from zero to one. The value of one indicates full consistency, that is, all cases are subsets of the outcome. The researcher should choose a consistency threshold which is preferably at least 0.85 (Ragin, 2007). In general, consistency scores between 0 and 0.75 indicate the existence of substantial inconsistency. A column, which is in the fsQCA software (Ragin *et al.*, 2006) termed "outcome", is then coded to note consistent and inconsistent cases.

Finally, the Quine–McCluskey algorithm of QCA (in the program) is employed in order to obtain the final solution. In total, two solutions are obtained: in the language of Ragin and Sonnett (2004), these are called the "complex" (or detailed) and "parsimonious" solutions. The parsimonious solution is generated by re-analyzing the truth table with the "remainder" rows (combinations lacking good instances) set to "don't care" (Ragin, 2007).

The solutions can be described in terms of consistency and coverage (Ragin, 2006). Consistency measures the accuracy of a solution, and is analogous to the configuration consistency presented above. Coverage measures the generality of the solution. Specifically, solution coverage describes the extent to which the solution covers the outcome. This is calculated as follows:

$$\mathit{Coverage} = \frac{\sum_{i=1}^{N} \min(\mathbf{X}_i, \mathbf{Y}_i)}{\sum_{i=1}^{N} \mathbf{Y}_i}.$$

The value of the coverage varies between zero and one. Values close to one imply high coverage.

Model Specifications

Outcome. Operationalizing the construct of dominance of an industrial cluster is challenging. Some of the suggested measures include international trade performance (Porter, 1990), overall average wage (Porter, 2003), employment growth (Clancy *et al.*, 2001; Porter, 2003), patenting (Porter, 2003) and rate of growth of exports or change in balance of trade (Clancy *et al.*, 2001). In this study, we decided to focus on firm-level measures that reflect the business performance of individual firms (cf. aggregate-level measures such as productivity). For each of the studied case countries, we calculate the country's share of the total output of the 20 largest paper and pulp firms operating in the case countries. Thus, the measure is primarily based on a ranking of all the paper and pulp firms in the case countries by their total production. With this measure we are able to track the changes that have taken place in the dominance of large paper and pulp firms originating from particular national clusters during the analysis period.

In turning the values of the INDUSTRY DOMINANCE outcome into fuzzy-set membership scores ranging from zero to one, the following procedures were followed. For the first three analysis time-points (i.e. 1938, 1950 and 1974), the set membership score of 1 was based on the maximum value of the industry dominance (e.g. in 1938 the highest value of the industry dominance score, 0.29 for Finland, was set to be 1). The country with the lowest industry dominance score was then assigned a value of 0. Finally, the set membership values for the countries between these two points were linearly interpolated based on their industry dominance score. In the last time-point, we followed a somewhat different procedure in deriving the fuzzy-set membership scores for the variable. Because the differences between industry dominance scores were exceptionally high in the time-point, the point of full set membership (i.e. full industry dominance) was set to 0.25. The zero set membership was then assigned based on the minimum industry dominance value, as in the other time-points. Also, following the other time-points, linear interpolation was used in assigning the membership scores for the dominance values between these two boundary values. The fuzzy-membership scores of the outcome for each time-point in each country are presented in Table 12, as also the fuzzy scores of all causal conditions discussed in the following section.

Table 12. Fuzzy-set membership scores for outcome and causal conditions

	OUTCOME	CAUSAL CONDITIONS						
	1938							
	Industry dominance	*Forest resources*	*Size of domestic market*	*Trade balance*	*Evolutionary change*	*Technological change*	*Cartels*	*Academic strength*
Germany	0.48	0.20	1.00	0.63	1.00	0.00	1.00	
United Kingdom	0.98	0.00	1.00	0.00	0.37	0.95	0.50	
France	0.00	0.53	0.81	0.49	0.93	0.26	1.00	
Sweden	0.35	1.00	0.00	0.91	0.09	1.00	1.00	
Finland	1.00	1.00	0.00	0.95	0.74	1.00	1.00	
Norway	0.29	0.00	0.00	0.69	0.00	0.64	0.25	
	1950							
Germany	0.17	0.38	1.00	0.13	1.00	0.00	0.25	0.66
United Kingdom	0.91	0.00	1.00	0.08	0.00	0.65	0.25	1.00
France	1.00	0.61	1.00	0.42	0.45	0.00	0.50	0.47
Sweden	0.97	1.00	0.01	0.96	0.32	0.21	0.50	0.99
Finland	0.77	1.00	0.00	1.00	0.44	1.00	1.00	0.50
Norway	0.00	0.03	0.00	0.66	0.00	0.27	0.25	0.00
	1974							
Germany	0.60	0.49	1.00	0.09	0.45	0.20	0.25	0.61
United Kingdom	1.00	0.00	1.00	0.00	0.81	0.22	0.25	1.00
France	0.61	0.82	1.00	0.23	0.69	0.00	0.25	0.48
Sweden	0.94	1.00	0.00	1.00	1.00	0.82	0.50	0.86
Finland	0.91	1.00	0.00	1.00	0.00	1.00	1.00	0.47
Norway	0.00	0.09	0.00	0.73	0.29	0.27	0.25	0.00
	2000							
Germany	0.58	0.55	1.00	0.27	0.39	0.06	0.25	0.55
United Kingdom	0.00	0.00	1.00	0.00	1.00	0.00	0.25	0.50
France	0.14	0.97	1.00	0.15	0.47	0.04	0.25	0.23
Sweden	0.82	1.00	0.00	1.00	0.06	0.42	0.50	1.00
Finland	1.00	1.00	0.00	1.00	0.00	1.00	0.25	1.00
Norway	0.07	0.18	0.00	0.88	0.15	0.27	0.25	0.00

Causal conditions. This section presents how we operationalized the studied antecedents and turned the values of the respected measures into fuzzy-set membership scores (i.e. causal conditions in fuzzy-set parlance) ranging from zero to one. The studied antecedents are (1) availability of key raw material resource for pulp and paper industry firms (i.e. supply of wood), (2) size of the domestic market, (3) trade balance related to paper imports and exports, (4) level of cartelization, (5) evolutionary change, (6) technological change, and (7) academic strength specific to the paper and pulp industry.

First, we operationalized the supply of wood as the total forest area in hectares in a focal country. As forest area data for every country for every year studied was not directly available, linear interpolation and extrapolation were used in estimating the values for the years: linear interpolation was conducted based on the two closest forest area values around the year in question (for the years 1950 and 1974), and extrapolation was based on the overall trend calculated based on the extreme values for which data was available (for the years 1938 and 2000). The fuzzy-set membership scores for the causal condition (FOREST RESOURCES) were derived by setting countries with more than 15,000 hectares of forest area fully in the set of countries with a high level of forest resources, and countries with less than 5000 hectares of forest area fully out of the set. We used linear interpolation in calibrating the scores for the forest area values between these two anchor values. This calibration efficiently enabled the elimination of irrelevant variation present in the values of the causal condition.

Second, the size of the domestic market was measured by the gross domestic product (GDP) of the country in the year in question. The fuzzy-set membership scores for the variable (SIZE OF DOMESTIC MARKET) were then derived by, first, setting the countries with more than a 25 per cent share of the total GDP in the case countries fully in the set of countries with a large domestic market, and countries with less than a 5 per cent share of the total GDP in the case countries fully out of the set. Second, scores for the countries between these anchor points were determined by linear interpolation.

Third, trade balance related to paper product imports and exports was simply measured by the difference between the paper product exports and imports (i.e. paper product exports – imports) in the focal country and year. We established the fuzzy-set membership scores for the respective causal condition (TRADE BALANCE) as follows. First, the anchor point for a set membership score of 1 was set to 2 million metric tons, and the respective point for the membership score of 0 was set to minus 2 million tons. Second, scores between these two anchor points were linearly interpolated. Consequently, in the maximum ambiguity point, the value of trade balance equaled 0 tons.

Fourth, assigning the membership scores for the causal condition related to level of cartelization (CARTELS) in the case countries was based more on qualitative reasoning. First, we read the relevant literature dealing with trade policy and cartels and combined a list or ranking of countries which were more or less cartelized or protected. Then, the list was shown to senior paper industry managers and its relevance was discussed. After these discussions, we revised the lists and combined a function which aimed to show how easy or difficult a certain country was from the entry/selling point of view. Based on this, membership scores for the level of cartelization in the case countries were set (five-value scaling was used: 1.00: fully in; 0.75: more or less in; 0.5: neither in nor out; 0.25: more or less out; and 0.00: fully out).

Fifth, evolutionary change was measured by annual turnover of the paper and pulp firms (i.e. number of entries plus exits divided by the number of firms in the previous period). For instance, for the year 1938, the value of the condition was calculated by summing up the entries and exits between the two studied years (i.e. 1910 and 1938), divided first by the number of firms in the previous period (i.e. 1910) and second by the number of years between the two studied years. The calibration of the values of the condition (EVOL CHANGE) for fuzzy-set membership scores was accomplished by setting the maximum value of the evolutionary change in every year to equal 1 and the minimum value to equal 0. Other values were then linearly interpolated.

Sixth, we operationalized technological change as the change in average width of the paper machines in a focal country between two studied years. The calibration of the condition (TECH CHANGE) was done as follows. First, the limits for the "fully out" membership (i.e. 0) were assigned in every year by the minimum value of the average width in the focal year (if change in the average width was negative in some country, the limit for the "fully out" set membership was set to 0 cm). Second, in the year 1938, the membership score of 1 was anchored to a value of 200 cm, in the year 1950 to 150, in the year 1974 to 700 and in the year 2000 to 1000.

Seventh, we measured academic strength related to the paper and pulp industry by the number of members in Tappi—the professional organization of the paper and pulp industries—from each case country. However, as data for 1938 was not available, it was not possible to generate values for the condition for this year. For the other years, fuzzy-membership scores for the condition (ACADEMIC STRENGTH) were first derived by setting the membership score of 0 based on the minimum number of Tappi members in the case countries in a certain year. Second, the membership score of 1 was anchored to 100 members in 1950, 250 members in 1974 and 500 members in 2000. Finally, values for the countries between these two points were linearly interpolated.

Results

We conducted four analyses for industry dominance in the paper and pulp industry, for the years 1938, 1950, 1974 and 2000. The fuzzy-set analyses proceeded as follows. First, we constructed truth tables of our data as described.[10] In total, we employed seven causal conditions in the models. However, the causal condition ACADEMIC STRENGTH is not included in the analysis for 1938 because of data restrictions, and the condition CARTELS is not included in the analysis for 2000 because cartelization no longer played a role in the industry in 2000. Second, we selected a frequency threshold to distinguish between configurations with adequate empirical instances and configurations treated as logical remainders. Third, we selected the consistency threshold to distinguish between consistent and inconsistent configurations. Both thresholds were chosen based on the recommendations by Ragin (2007). Fourth, the Quine–McCluskey algorithm of QCA was employed to obtain the final solution. In the following sections we present the results of these analyses. Although both the complex and parsimonious solutions are presented, we primarily focus on

[10] We conducted our analyses with fsQCA 2.2 software (Ragin *et al.*, 2006). The program can be downloaded from the website: www.fsqca.com

interpreting the complex solutions; this is because many of the parsimonious solutions can be considered to be "too parsimonious" (cf. Ragin and Sonnett, 2004) because the simplifying assumptions that are incorporated via counterfactual analysis are untenable (i.e. the rows in the truth table that have no empirical evidence).

Industry Dominance in 1938

Table 13[11] presents the results of the industry dominance analysis for the case countries in 1938. Because of the considerably small size of the sample, the frequency threshold value is set to one. The consistency cutoff value, on the other hand, is set to 0.81. Below this cutoff value, the consistency cutoff values of the remaining configurations drop significantly below the absolute minimum consistency threshold of 0.75 suggested by Ragin (2007).

The results for the analysis (complex solution) indicate one path to industry dominance: it consists of a combination of a high level of forest resources, small size of the domestic market, a positive trade balance, a high level of evolutionary change, a high level of technological change and a high level of cartelization. The country fulfilling these characteristics in the sample is especially Finland. However, the overall coverage of the solution is quite low (0.27), indicating that some important causal conditions associated with industry dominance may be missing from the truth table (cf. Ragin, 2007).

Industry Dominance in 1950

Table 14 presents the analysis results for 1950. We set the frequency cutoff to 1 and the consistency cutoff to 0.94. Based on the table, the complex results imply two paths to industry dominance. The first path combines all seven conditions: a low level of forest resources, large size of the domestic market, a negative trade balance, a low level of evolutionary change, a high level of technological change, a low level of cartelization and a high level of academic strength. The second path, on the other hand, combines the following seven conditions: a high level of forest resources, small size of the domestic market, a strong positive trade balance, a low level of evolutionary change, a high level of technological change, a high level of cartelization and a low level of academic strength. The conditions in the two paths are opposite with the exception of two conditions: a low level of evolutionary change and a high level of technological change are present in both paths. The representative of the first path in the sample is especially the UK. On the other hand, Finland and Sweden have many characteristics in common with the second path.

[11] The notations with which the causal conditions can be combined, and which are used in the table, are as follows. First, *negation* of the causal condition can be calculated simply by subtracting its membership in set A from 1, as follows: (membership in set *not*-A) = 1 – (membership in set A). In this study, causal conditions are denoted by capital letters. Its negation, on the other hand, is denoted by small letters. Second, intersection takes place when two or more sets are combined. This logical *and* is accomplished by taking the minimum membership score of each case in the sets that are combined. The minimum membership score, in effect, indicates the degree of membership of a case in a combination of sets (Ragin, 2007). In this study, logical *and* is denoted by "•". Third, two or more sets can be joined through logical *or* (the union of the sets). This is calculated as the maximum of the membership scores, and in this study is denoted by " + ".

Table 13. Complex and parsimonious solutions for the industry dominance in 1938

Complex solution		**Parsimonious solution**	
1. FOREST RESOURCES•size of domestic market•TRADE BALANCE•EVOL CHANGE•TECH CHANGE•CARTELS		1. size of domestic market•EVOL CHANGE + 2. FOREST RESOURCES•EVOL CHANGE•TRADE BALANCE + 3. EVOL CHANGE•TECH CHANGE	
Frequency cutoff	1		
Consistency cutoff	0.81		
Solution Indices		Solution Indices	
N	6	N	6
Consistency	0.81	Consistency	0.74
Coverage	0.27	Coverage	0.45

Table 14. Complex and parsimonious solutions for industry dominance in 1950

Complex solution		**Parsimonious solution**	
1. forest resources•SIZE OF DOMESTIC MARKET• trade balance•evol change•TECH CHANGE•cartels• ACADEMIC•STRENGTH + 2. FOREST RESOURCES•size of domestic market• TRADE BALANCE•Evol change•TECH CHANGE• CARTELS•academic strength		1. TECH CHANGE	
Frequency cutoff	1		
Consistency cutoff	0.94		
Solution Indices		Solution Indices	
N	6	N	6
Consistency	0.97	Consistency	0.77
Coverage	0.30	Coverage	0.43

Industry Dominance in 1974

Table 15 shows the results for the industry dominance analysis for 1974. As can be noticed, we select the frequency cutoff to be 1 and the consistency cutoff to be 0.85. The consistency of the solution is 0.96 and the coverage 0.56.

We now identify three independent paths to dominance. All the paths are considerably different. The first path for dominance combines a low level of forest resources, large size of the domestic market, a positive trade balance, a low level of technological change, a low level of cartelization and a high level of academic strength. The second combines a high

Table 15. Complex and parsimonious solutions for industry dominance in 1974

Complex solution		**Parsimonious solution**	
1. forest resources•SIZE OF DOMESTIC MARKET•trade balance•tech change•cartels•ACADEMIC STRENGTH +		1. SIZE OF DOMESTIC MARKET (GDP) +	
2. FOREST RESOURCES•SIZE OF DOMESTIC MARKET•EVOL CHANGE•trade balance•tech change•cartels•academic strength +		2. FOREST RESOURCES +	
3. FOREST RESOURCES•size of domestic market•TRADE BALANCE•evol change•TECH CHANGE•CARTELS•academic strength		3. TRADE BALANCE	
Frequency cutoff	1		
Consistency cutoff	0.85		
Solution Indices		Solution Indices	
N	6	N	6
Consistency	0.96	Consistency	0.78
Coverage	0.56	Coverage	1

level of forest resources, large size of the domestic market, a high level of evolutionary change, a negative trade balance, a low level of technological change, a low level of cartelization and a low level of academic strength. Finally, the third path combines a high level of forest resources, small size of the domestic market, a positive trade balance, a low level of evolutionary change, a high level of technological change, a high level of cartelization and a low level of academic strength. As regards the countries in our sample, the last path fits the two small-size countries, Finland and Sweden, and the first two paths more the large countries in the sample, especially the UK.

Industry Dominance in 2000

Finally, Table 16 presents the results for industry dominance in 2000. As regards the basic indices, the frequency cutoff was set to one and the consistency cutoff to 0.88. If we consider the complex solution as the preferred one (consistency 0.92; coverage 0.96), the following implications can be made.

Now, the results imply two paths to dominance. The first path combines the following conditions: a high level of forest resources, large size of the domestic market, a negative trade balance, a low level of evolutionary change, a low level of technological change and a high level of academic strength. The second path, on the other hand, combines a high level of forest resources, small size of the domestic market, a positive trade balance, a low level of evolutionary change and a high level of academic strength. The latter path is strongly supported by the data (i.e. by the countries of Finland and Sweden).

Discussion and Conclusions

One of the persistent myths in management practice is the longevity of competitive advantage of large firms. However, this assumption does not hold in the light of historical

Table 16. Complex and parsimonious solutions for industry dominance in 2000

Complex solution		**Parsimonious solution**	
1. FOREST RESOURCES•SIZE OF DOMESTIC MARKET •trade balance•evol change•tech change •ACADEMIC STRENGTH +		1. FOREST RESOURCES•ACADEMIC STRENGTH +	
2. FOREST RESOURCES•size of domestic market• TRADE BALANCE•evol change•ACADEMIC STRENGTH		2. evol change•ACADEMIC STRENGTH	
Frequency cutoff	1		
Consistency cutoff	0.88		
Solution Indices		Solution Indices	
N	6	N	6
Consistency	0.92	Consistency	0.90
Coverage	0.96	Coverage	0.96

research. As Foster and Kaplan (2001: 41), two McKinsey consultants, conclude in their massive research on the survival of large corporations "... the corporate equivalent of El Dorado—the golden company that continually outperforms the market—has never existed". The overall picture of their study of 1000 companies in 15 industries resembles the tradition of evolutionary studies in industrial organization literature (Klepper, 1996; Murmann, 2003) that underlines the impact of industry life-cycle phase, age and size of an organization, and the amount of research and development investments on the probability of firm survival. Although rich in its theoretical underpinnings in evolutionary theory (overview in Nelson, 1995) and Austrian economics (Schumpeter, 1934) the field of evolutionary strategy is still not complete when it comes to comparative analysis of different national settings. Our research targets this question: to what extent does the nationality of firms explain competitive position of large firms and what factors are sufficient to result in competitive advantage of large firms at a specific point in time.

The central results of our exploratory study are, first, the notion that some countries are continuously able to raise successful companies whereas other countries manifest a relative decline after a temporal success. In our case, Finland and Sweden have been continuously successful in terms of large firms in the top-20 ranking and also in terms of technological efficiency. On the contrary, the originally dominant countries (UK and Norway) almost lost their ability to create dominant large firms during the twentieth century.

Second, the size of the firm populations in the specific countries varied considerably, but correlates with the number of inhabitants (many firms in large countries; few firms in small countries). Over time, however, each country produced a number of large firms. This pattern also continued throughout our period of analysis, although we report the relative decline and rise of some nations. Another steady pattern in the industry evolution was that an infinite number of large firms exhibited efficiency in terms of production/machine. This seems not to be dependent on the country of origin. Thus, the differences in efficiency at *country level* are most probably a result of the population size rather than nation-specific technological know-how.

The third key result is novel both in the context of evolutionary and cluster literatures. Namely, our fuzzy-set analysis demonstrates that (a) the sources of competitive advantage of large firms vary between different historical periods and (b) several causal pathways can lead to competitive advantage of large firms. More specifically, the identified different paths to success imply that the most important resources (in our case raw materials, energy and customers) may be unequally distributed among countries. For example, countries with large forests lack proximity to customers. On the contrary, countries with proximate customers lack forests and hydropower. Despite a lack of some resources, countries may produce successful firms. Thus, we may state the following: a set of resources is a necessary but not sufficient cause for competitive advantage of large firms.

What is more, in the case of large countries/firm populations (Germany, France, UK), a baseline model of industry evolution logically explains the emergence and survival of large companies as the result of variation (hundreds of companies), selection (over time only some firms survive and grow) and retention. In the case of small countries/firm populations, the evolutionary competition seems to have less explanatory power. This is a contradictory finding vis-à-vis existing literature. Previously, for example, Murmann (2003) found empirical confirmation in the synthetic dye industry that more start-ups, *ceteris paribus*, increase the odds that some firms will be successful. Thus, our finding that a country with a low number of firm entries (Finland) has been continuously successful creating the largest firm in the European context raises important theoretical questions. Our interpretation is that small countries may provide a different environment in which firms learn to adapt to changing environments in a way that is not possible in larger countries. For example, we may argue that the way of organizing the key processes (production, marketing and logistics) of a firm may explain the size and survival rate of the initially large companies. In other words, because of distant markets and increasing competition, Finnish, Swedish and Norwegian companies needed to (perhaps prematurely) emphasize scale and scope dimension in their business activities.

Acknowledgements

All authors contributed equally. Author names are in alphabetical order. The authors would like to thank the discussants and reviewers of the 2009 Academy of Management Conference and Ecis workshop on “Technological Discontinuities and Transitions: Evolution Theory and Inter-disciplinary Crossovers” in May 2008. An earlier version is the winner of the Carolyn Dexter Award at the 2009 Academy of Management Conference, Chicago. The authors are indebted to Mikko Lauerma for research assistance and Kalle Pajunen for helpful comments. The project was financed by the Academy of Finland and TEKES.

References

Barnett, W. P., Greve, H. R. and Park, D. Y. (1994) An evolutionary model of organizational performance, *Strategic Management Journal*, 15(Winter), pp. 11–28.

Barney, J. B. (1991) Firm resources and sustained competitive advantage, *Journal of Management*, 17(1), pp. 99–120.

Best, M. (2001) The New Competitive Advantage (Oxford: Oxford University Press).

Birkner (1900–1975) *Birkner. Handbuch der Papier-Industrie Europas*, several vols (Darmstadt: Verlag Birkner).

Blundel, R. and Thatcher, M. (2005) Contrasting local responses to globalization: the case of volume yacht manufacturing in Europe, *Entrepreneurship and Regional Development*, 17(November), pp. 405–429.

Brock, W., Magee, S. P. and Young, L. (1989) *Black Hole Tariffs Endogenous Policy Theory* (Cambridge: Cambridge University Press).

Brouthers, K. D., Brouthers, L. E. and Werner, S. (2008) Resource-based advantages in an international context, *Journal of Management*, 34(2), pp. 189–217.

Camison-Zornoza, C., Lapiedra-Alcami, R., Segarra-Cipres, M. and Boronat-Navarro, M. (2004) A meta-analysis of innovation and organizational size, *Organization Studies*, 25(3), pp. 331–361.

Cassis, Y. (1997) *Big Business: The European Experience in the Twentieth Century* (Oxford: Oxford University Press).

Chandler, A. D. (1962) *Strategy and Structure: Chapters in the History of the Industrial Enterprise* (Cambridge, MA: MIT Press).

Chandler, A. D. (1977) *The Visible Hand* (Cambridge, MA: The Belknap Press of Harvard University Press).

Chandler, A. D. J. (1990) *Scale and Scope. The Dynamics of Industrial Capitalism* (Cambridge, MA: The Belknap Press of Harvard University Press).

Christensen, C. M., Suarez, F. F. and Utterback, J. M. (1998) Strategies for survival in fast-changing industries, *Management Science*, 44(12), pp. S207–S220.

Clancy, P., O'Malley, E., O'Connel, L. and Van Egeraat, C. (2001) Industry clusters in Ireland: an application of Porter's model of national competitive advantage to three sectors, *European Planning Studies*, 9(1), pp. 7–28.

Coleman, D. C. (1958) *The British Paper Industry 1495–1860* (Oxford: Clarendon Press).

Dhanaraj, C. and Parkhe, A. (2006) Orchestrating innovation networks, *Academy of Management Review*, 31(3), pp. 659–669.

Diesen, M. (1998) *Economics of Pulp and Paper Industry. Paper Making Science & Technology* (Helsinki: Fapet).

Diouf, J. (2007) FAO—a knowledge organization for the third millennium, *Unisylva. An International Journal of Forestry and Forest Industries*, 58(1/2), pp. 5–6.

Dobrev, S. D., Kim, T. Y. and Hannan, M. T. (2001) Dynamics of niche width and resource partitioning, *American Journal of Sociology*, 106(5), pp. 1299–1337.

Dykes Spicer, A. (1907) *The Paper Trade. A Descriptive and Historical Survey of the Paper Trade from the Commencement of the Nineteenth Century* (London: Methuen).

Fasting, K. (1968) *Den Norske Papirindustris Historia 1893–1968* (Oslo).

Fiss, P. C. (2007) A set-theoretic approach to organizational configurations, *Academy of Management Review*, 32(4), pp. 1180–1198.

Foster, R. and Kaplan, S. (2001) *Creative Destruction: Why Companies that are Built to Last Underperform the Market—And How to Successfully Transform Them* (New York: Doubleday Business).

Galambos, L. (1988) What have CEOs been doing?, *The Journal of Economic History*, 48(2), pp. 243–258.

Geroski, P. A. (1998) An applied econometrician's view of large company performance, *Review of Industrial Organization*, 13(3), pp. 271–293.

Gold, S. (2003) *The Development of European Forest Resources, 1950 to 2000: A Better Information Base. A Study Implemented in the Framework of the European Forest Sector Outlook Study (EFSOS)* (Geneva: United Nations).

Hazley, C. (2000) *Forest-Based and Related Industries of the European Union: Industrial Districts, Clusters and Agglomerations* (Helsinki: Taloustieto).

Healey, M. J. and Dunham, P. J. (1994) Changing competitive advantage in a local economy: the case of Coventry, 1971–90, *Urban Studies*, 31(8), pp. 1279–1302.

Häggblom, R. (1999) The forest cluster is becoming global and more compact, in: A. Reunala, I. Tikkanen & E. Åsvik (Eds), *The Green Kingdom. Finland's Forest Cluster*, pp. 296–301 (Helsinki: Otava Publishing Ltd–Metsämiesten Säätiö Foundation).

John, C. H. and Pouder, R. W. (2006) Technology clusters versus industry clusters: resources, networks, and regional advantages, *Growth and Change*, 37(2), pp. 141–171.

Katz, A., Vom Hau, M. and Mahoney, J. (2005) Explaining the great reversal in Spanish America: fuzzy-set analysis versus regression analysis, *Sociological Methods & Research*, 33(4), pp. 539–573.

Kettunen, J. (2002) *Kuuseen kurkottajat. Teknologian kehitys Metsäliiton piirissä 1950-luvulta vuosituhannen vaihteeseen* (Helsinki: Metsäliitto-yhtymä).

Klepper, S. (1996) Entry, exit, growth, and innovation over the product life cycle, *The American Economic Review*, 86(3), pp. 562–583.

Klepper, S. (2002) Firm survival and evolution of oligopoly, *The RAND Journal of Economics*, 33(1), pp. 37–61.

Kogut, B. (Ed.) (1993) *Country Competitiveness: Technology and the Organization of Work* (New York: Oxford University Press).

Kogut, B., MacDuffie, J. P. and Ragin, C. C. (2004) Prototypes and strategy: assigning causal credit using fuzzy sets, *European Management Review*, 1(2), pp. 114–131.

Krawany, F. v. (1910) *Internationale Papier-Statistik* (Berlin: Verlag für Fachliteratur).

Krueger, A. O. (1974) The political economy of the rent seeking society, *American Economic Review*, 64(3), pp. 291–303.

Krugman, P. (1991) Increasing returns and economic-geography, *Journal of Political Economy*, 99(3), pp. 483–499.

Krugman, P. and Venables, A. J. (1995) Globalization and the inequality of nations, *Quarterly Journal of Economics*, 110(4), pp. 857–880.

Lai, H. and Shyu, J. Z. (2005) A comparison of innovation capacity at science parks across the Taiwan Strait: the case of Zhangjiang High-Tech Park and Hsinchu Science-based Industrial Park, *Technovation*, 25, pp. 805–813.

Lamberg, J.-A. and Laurila, J. (2005) Materializing the societal effect: organizational forms in the change of paper industry dominance, *Organization Studies*, 26(12), pp. 1809–1830.

Lamberg, J.-A. and Ojala, J. (2006) Evolution of competitive strategies in global forestry industries: introduction, in: J.-A. Lamberg, J. Näsi, J. Ojala & P. Sajasalo (Eds), *The Evolution of Competitive Strategies in Global Forestry Industries: Comparative Perspective*, pp. 1–29 (Dordrecht: Springer).

Landberg, E., Lyche, B. and Ojala, O. O. (Eds) (1950) *Brusewitz Nordisk Papperskalender 1950–1951* (Göteborg: Hugo Brusewitz Ab).

Lawson, C. and Lorenz, E. (1999) Collective learning, tacit knowledge and regional innovative capacity, *Regional Studies*, 33(4), pp. 305–317.

Lin, C., Tung, C. and Huang, C. (2006) Elucidating the industrial cluster effect from a system dynamics perspective, *Technovation*, 26, pp. 473–482.

Lund, A. (1999) *Förteckning över pappersmaskiner i Finland 1842–1998* (Åbo).

Lundvall, B.-Å. (2007) National innovation systems—analytical concept and development tool, *Industry and Innovation*, 14(1), pp. 95–119.

Lundvall, B.-Å., Johnson, B., Andersen, E. S. and Dalum, B. (2002) National systems of production, innovation and competence building, *Research Policy*, 31(2), pp. 213–231.

Lyrholm, T. L. (Ed.) (1950) *Handbook of the Northern Wood Industries 1950. Timber, Woodpulp, Paper. Sweden–Norway–Finland* (Stockholm: A. B. Svensk Trävaru-Tidning).

Maddison, A. (2001) *The World Economy: A Millenium Perspective* (Paris: OECD).

McGahan, A. M. and Silverman, B. S. (2001) How does innovative activity change as industries mature?, *International Journal of Industrial Organization*, 19(7), pp. 1141–1160.

Moen, E. (1998) *The Decline of the Pulp and Paper Industry in Norway, 1950–1980. A Study of a Closed System in an Open Economy* (Oslo: Scandinavian University Press).

Morosini, P. (2004) Industrial clusters, knowledge integration and performance, *World Development*, 32(2), pp. 305–326.

Mowery, D. C. and Nelson, R. R. (Eds) (1999) *Sources of Industrial Leadership: Studies of Seven Industries* (New York: Cambridge University Press).

Munsell, J. (1980) *Chronology of Origins of Paper and Paper-Making* (New York: Garland).

Murmann, J. P. (2003) *Knowledge and Competitive Advantage: The Coevolution of Firms, Technology, and National Institutions* (Cambridge, MA: Cambridge University Press).

Nelson, R. R. (Ed.) (1993) *National Innovation Systems* (New York: Oxford University Press).

Nelson, R. R. (1995) Recent evolutionary theorizing about economic change, *Journal of Economic Literature*, 33(1), pp. 48–90.

Nelson, R. R. and Winter, S. G. (1982) *An Evolutionary Theory of Economic Change* (Cambridge, MA: The Belknap Press of Harvard University Press).

North, D. C. (1990) *Institutions, Institutional Change, and Economic Performance* (Cambridge and New York: Cambridge University Press).

Ojala, J., Lamberg, J.-A., Ahola, A. and Melander, A. (2006) The ephemera of success: strategy, structure and performance in the forestry industries, in: J.-A. Lamberg, J. Näsi, J. Ojala & P. Sajasalo (Eds), *The Evolution of Competitive Strategies in Global Forestry Industries: Comparative Perspectives*, pp. 257–286 (Dordrecht: Springer).

Osakeyhtiöt (1937–1973) *Suomen pankit ja osakeyhtiöt* [Banks and Limited Liability Companies in Finland], several vols (Helsinki: Kustannusosakeyhtiö liiketieto).

Pajunen, K. (2008) Institutions and inflows of foreign direct investment: a fuzzy-set analysis, *Journal of International Business Studies*, 39(4), pp. 652–669.

Patel, P. and Pavitt, K. (1997) The technological competencies of the world's largest firms: complex and path-dependent, but not much variety, *Research Policy*, 26(2), pp. 141–156.

Pavitt, K., Robson, M. and Townsend, J. (1987) The size distribution of innovating firms in the UK—1945–1983, *Journal of Industrial Economics*, 35(3), pp. 297–316.

Pennings, P. (2003) Beyond dichotomous explanations: explaining constitutional control of the executive with fuzzy-sets, *European Journal of Political Research*, 42(4), pp. 541–568.

Perlis, A. (Ed.) (2007) *Unisylva. An International Journal of Forestry and Forest Industries*, 58 (1/2).

Phillips (1910) *Phillips' Paper Trade Directory of the World 1909–1910* (London: S. C. Phillips & Co.).

Phillips (1950) *Phillips' Paper Trade Directory of the World 1950* (London: S.C. Phillips & Co.).

Phillips (1971) *Phillips' Paper Trade Directory of the World 1971* (London: S.C. Phillips & Co.).

Phillips (1974) *Phillips' Paper Trade Directory Europe/Mills of the World 1974* (London: Benn Brothers Limited).

Phillips (2000) *International Phillips 2000 Paper Directory* (Tonbridge, Kent: Miller Freeman UK Ltd).

Pinch, S., Henry, N., Jenkins, M. and Tallman, S. (2003) From "industrial districts" to "knowledge clusters": a model of knowledge dissemination and competitive advantage in industrial agglomerations, *Journal of Economic Geography*, 3(4), pp. 373–388.

Porter, M. E. (1990) *The Competitive Advantage of Nations* (New York: Free Press).

Porter, M. E. (2003) The economic performance of regions, *Regional Studies*, 37(6/7), pp. 549–578.

Ragin, C. C. (2000) *Fuzzy-Set Social Science* (Chicago and London: University of Chicago Press).

Ragin, C. C. (2006) Set relations in social research: evaluating their consistency and coverage, *Political Analysis*, 14(3), pp. 291–310.

Ragin, C. C. (2007) Qualitative comparative analysis using fuzzy sets (fsQCA), in: B. Rihoux & C. C. Ragin (Eds), *Configurational Comparative Analysis*, pp. 87–121 (Thousand Oaks, CA: Sage).

Ragin, C. C., Drass, K. A. and Davey, S. (2006) *Fuzzy-Set/Qualitative Comparative Analysis 2.2* (Tucson: Department of Sociology, University of Arizona).

Ragin, C. C. and Sonnett, J. (2004) Between complexity and parsimony: limited diversity, counterfactual cases and comparative analysis, in: S. Kropp & M. Minkenberg (Eds), *Vergleichen in der Politikwissenschaft* (Wiesbaden: VS Verlag fur Sozialwissenschaften).

Rjestoff, N. A. (1913) Pappret i Ryssland, *Finska Pappersindustriidkarenes förbund. Meddelande,* (3).

Salzman, F. (1911) *Die Papierindustrie. Ihre wirtschafliche Entwicklung und Heutige Lage* (Berlin: Franz Siemenroth).

Schumpeter, J. A. (1934) *The Theory of Economic Development* (New York: Oxford University Press).

Statistik (1972) *Historisk statistik för Sverige. Del 3. Utrikeshandel 1732–1970* (Lund: Statistiska Centralbyrån).

Statistikk (1978) *Historisk Statistikk* [Historical Statistics 1978] (Oslo: Statistisk sentralbyrå [Central Bureau of Statistics]).

Statistikk (1995) *Historisk Statistikk 1994* [Historical Statistics 1994] (Oslo: Statistisk sentralbyrå [Statistics Norway]).

Sölvell, Ö., Lindqvist, G. and Ketels, C. (2003) *The Cluster Initiative Greenbook* (Stockholm: Bromma Tryck AB).

Tallman, S., Jenkins, M., Henry, N. and Pinch, S. (2004) Knowledge, clusters, and competitive advantage, *Academy of Management Review*, 29(2), pp. 258–271.

Tappi (1932–1972) *Technical Association of the Pulp and Paper Industry. Yearbook 1932–1972*, several vols (New York: Tappi).

Teece, D. J., Pisano, G. and Shuen, A. (1997) Dynamic capabilities and strategic management, *Strategic Management Journal*, 18(7), pp. 509–533.

Toivanen, H. (2004) Learning and corporate strategy: the dynamic evolution of the North American pulp and paper industry, 1860–1960. Unpublished Dissertation, Georgia Institute of Technology, Georgia.

UNECE (1964–2006) *FAO Statistics, UNECE Timber Database, 1964–2006, as of July 2007* (United Nations).

Vattula, K. (Ed.) (1983) *Suomen taloushistoria 3, Historiallinen tilasto* [Historical Statistics] (Helsinki: Tammi).

Walker, M. I. and Minnitt, R. C. A. (2006) Understanding the dynamics and competitiveness of the South African minerals inputs cluster, *Resources Policy*, 13, pp. 12–26.

Wilk, E. and Fernsterseifer, J. E. (2003) Use of resource-based view in industrial cluster strategic analysis, *International Journal of Operations & Management*, 23(9), pp. 995–1009.

Williamson, O. E. (1975) *Markets and Hierarchies* (New York: Free Press).