The Nanoeconomic Logic of Entry and Exit: Evidence from 174 Years of Paper and Pulp Making

Juha-Antti Lamberg  
University of Jyväskylä  
History and Ethnology  
juha-antti.lamberg@jyu.fi  

Mirva Peltoniemi  
Jyväskylä University School of Business and Economics  
Strategy and Entrepreneurship  
mirva.peltoniemi@jyu.fi  

Abstract  
Industry life-cycle theory is a powerful explanation for the success of the largest and oldest survivors and the exit of the smallest and most vulnerable firms. However, it is less helpful in the study of the complex interplays of institutional and governance environments and entrepreneurial volition. We study a population of 98 firms over 174 years. Our detailed analysis of technology adoption reveals a fixed pattern of investments, which helps to explain the survival of the remaining firms. However, the reasons for non-investments and subsequent firm exits originate in the incentive schemata of owners and entrepreneurs strongly modified by dynamics in the governance structures. Overall, our study confirms the importance and further contributes to the understanding of the nanoeconomics in industry evolution.
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Abstract: Industry life-cycle theory is a powerful explanation for the success of the largest and oldest survivors and the exit of the smallest and most vulnerable firms. However, it is less helpful in the study of the complex interplays of institutional and governance environments and entrepreneurial volition. We study a population of 98 firms over 174 years. Our detailed analysis of technology adoption reveals a fixed pattern of investments, which helps to explain the survival of the remaining firms. However, the reasons for non-investments and subsequent firm exits originate in the incentive schemata of owners and entrepreneurs strongly modified by dynamics in the governance structures. Overall, our study confirms the importance and further contributes to the understanding of the nanoeconomics in industry evolution.

Keywords: Industry life cycle; business history; paper and pulp industry; Finland; new institutional economics
Introduction

Why some firms survive and some fail is one of the fundamental questions of strategic management (Suarez & Utterback, 1995). Industrial organization, macrosociology, and business history offer a consistent explanation: surviving firms are able and willing to make the necessary investments in process innovations, and have the resources to make technology leaps when necessary (Klepper, 2002a). The existing literature also predicts the survivors to be large firms with a long tenure and which manifest a high level of legitimacy (Rao, 1994). In contrast, firms that exit do so because of a lack of resources and/or insufficient capabilities (Agarwal, 1996; Fontana & Nesta, 2009).

These studies, however, have underemphasized the nano-level dynamics of survival and failure (Braguinsky & Hounshell, 2016) where industry-level outcomes are dependent on the interplay of institutional setting and entrepreneurial volition. Moreover, recent critique of the simplistic treatment of survival and failure (Fortune & Mitchell 2012; Josefy et al., 2017) has prompted us to gain a more nuanced understanding of how and why certain firms survive, others are acquired, and others are dissolved. We argue that, in addition to the technological investment and economies of scale logic familiar from the industry life cycle theory, we need to put more emphasis on institutions and governance systems, institutional shocks, and entrepreneurial volition in order to gain an elaborated theoretical understanding of the causal structure of entry and exit dynamics. This means examining industry evolution from the perspective of individual decision-making situations and concurrently explaining entry and exit dynamics as an aggregation of this nano-level evidence.
As is typical in abductive research (Ketokivi & Mantere, 2010), our empirical results emerged as a mystery we needed to solve. After weighing several competing theoretical framings, we found the strongest explanatory support from governance (Williamson, 1991; Argyres & Liebeskind, 1999) and institutional theories (North, 1990; Bjørnskov & Foss, 2016). The results of these studies were of particular interest for the understanding of our own findings. Argyres and Bigelow (2007), for example, propose in their study of the early evolution of the U.S. auto industry that governance mode is an important causal factor in the period of shakeout (Bigelow & Argyres, 2008), and that population-level dynamics likewise explain make-or-buy decisions. Similarly, Braguinsky and Hounshell (2016) and Murmann (2003) have noted the crucial role—in a negative as well as positive sense—of governments as enforcement and designing mechanisms (North, 1990) in the evolution of institutional frameworks. Murmann’s studies (2003, 2013) are important because they highlight the endogenous nature of institutions in the evolution of the synthetic dye industry. Braguinsky (e.g., Braguinsky & Hounshell, 2016; Braguinsky, 2015) has especially focused on the dynamics between individual-level entrepreneurship and institutional frameworks. We follow this lead by focusing on the interplay of institutional factors and entrepreneurial volition across historical processes. In addition, studies on entries and exits have found that economic shocks (e.g., Garcia-Sanchez et al., 2014) and innovation shocks (e.g., Argyres et al., 2015) play a role because they change the rules of the game. We propose that institutional shocks may have a similar role as an important element in the explanation of decision-making situations.

In order to address the roles of institutional shocks and entrepreneurial volition in industry evolution, we study the evolution of a nationally important population of firms in the Finnish paper and pulp industry—a population that has produced several of the world’s largest paper
industry companies (currently three in the global top 10) and has been seen as a technological forerunner since the 1970s. In our analysis, we trace the distinct firm-specific pathways to survival and failure for the whole population of firms. We focus on complex causalities between firm characteristics, including technological choices, material supply, political economy of funding, location, social capital and succession, and survival.

On the surface, the evolution of the industry seems predictable given sufficient knowledge of industry life-cycle theory and an overall understanding of the sources of competitive advantage (see Figure 1). However, in the early phase of our research, we identified several evolutionary archetypes. The identification of these evolutionary archetypes also resulted in an understanding of the causal mechanisms of why they evolve as well as of why and how such clustering produces the inverted u-shape macro-level evolutionary cycle predicted by the industry life-cycle theory. In this sense, we answer the call to qualitatively understand entry and exit throughout the industry life cycle (Peltoniemi, 2011) while simultaneously demonstrating the central effect of history-specific institutional and governance dynamics as antecedents of firm entries and exits.

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Our contributions are three-fold. First, we contribute to the growing stream of nanoeconomic industry life-cycle studies by addressing the role of institutional shocks in explaining firm and industry-level outcomes. Second, we unpack the concept of entrepreneurial volition by showing the causal complexity each investment decision necessarily activates. Finally, our historical understanding of nano-level decision-making logic and the overall richness of our empirical study enhances the research on survival and failure by going beyond the binary
conceptualizations and focus on macro-level data in the explanation of micro- and nano-level dynamics.

**Literature Review**

Steven Klepper (1996, p. 23) has summarized the basic assumptions regarding product life cycle as follows:

> When industries are new, there is a lot of entry, firms offer many different versions of the industry's product, the rate of product innovation is high, and market shares change rapidly. Despite continued market growth, subsequently entry slows, exit overtakes entry and there is a shakeout in the number of producers, the rate of product innovation and the diversity of competing versions of the product decline, increasing effort is devoted to improving the production process, and market shares stabilize.

Since the publication of this article, numerous empirical studies have validated Klepper’s (1996; 1997; 2002b) theoretical modeling and empirical observations. The industries studied to date that largely verify Klepper’s assumptions include, for example, tires (Jovanovic & Macdonald, 1994), cars (Cantner et al., 2009), PCs (Bayus & Agarwal, 2007), telecommunications (Fontana et al., 2015) and fashion (Wenting & Frenken, 2011). Moreover, panel studies including a variety of industries, from gas turbines, vacuum cleaners, and antibiotics to guided missiles, have provided compelling evidence for the predictions of the industry life-cycle theory (e.g., Cefis & Marsili, 2012; Huergo & Jaumandreu, 2004; Kronborg & Thomsen, 2009; Persson, 2004).

In conclusion, the baseline assumptions regarding a manufacturing industry’s life cycle—excluding the exceptions listed in Klepper and Simons (2005) and Peltoniemi (2011)—would be the following:
1) Due to economies of scale in R&D and manufacturing and competition, an initial high entry rate is followed by a wave of firm exits, resulting in an inverted u-curve-shaped density figure.

2) New generations of product innovations and new technologies first motivate entries, while later a rising investment burden results in firm exits. The most intensive exit phase is called shake-out.

3) Product R&D decreases over time as the results are suspect to spillover dynamics (i.e., firms are not able to sustain their rents).

4) Process R&D increases over time as firms are able to endogenize the results, resulting in sustained efficiency gains.

5) As the number of firms goes down and the efficiency of individual firms goes up, the joint function is price decline in the end market.

6) Declining prices and increasingly efficient producers function as barriers to entry.

What the existing theoretical and industry-specific literature lacks, therefore, is the extent to which firm-level dynamics differ from what ILC theory predicts. To address this gap, we set out to answer the following questions in our empirical study:

1. What types of firms entered in each period?
2. What types of firms survived in each period?
3. What types of firms exited in each period?
4. How did the determinants of survival/death change over time?
As is typical in abductive research (Ketokivi & Mantere, 2010), our detailed examination of these questions motivated us to seek alternative complementary explanations. While the existence of market competition and capabilities of founders have been core elements in ILC theorizing, we realized that the story is more complicated: changes in the institutional environment and nanoeconomics related both to the founding of firms and their strategic management clearly played larger roles as selection mechanisms than a standard ILC reading would predict. Literature has found both of these factors to be important evolutionary mechanisms, but rarely in combination. Accordingly, our theoretical aim is to move towards an understanding that simultaneously takes into account institutional as well as individual-level factors in the explanation of industry life-cycle dynamics.

Although the combination of technological development and market dynamics is the baseline assumption for sufficient explanation of entry and exit patterns (Peltoniemi, 2011), the effect of institutional regimes is also noted in many empirical and theoretical studies. Dobrev (1999), for example, has studied the effect of political changes on the population of Bulgarian newspaper companies, finding significant effects on both entry and exit patterns when the political regime of the country changed. For evolutionary scholars (e.g., Nelson, 1993), the effect of the institutional environment is also important, especially for scholars studying economic growth (Acemoglu, Johnson, & Robinson, 2005). In these studies, the growth of industries and businesses is necessary for economic growth, and a functioning and predictable institutional framework is needed for efficient and profitable business transactions (North, 1990). More recently, attention has shifted to institutional barriers (Chang & Wu, 2014) as well as to buffering and enabling political ties (Zheng et al., 2015) as factors preventing or modifying market selection forces in industry evolution.
The above studies largely treat institutions as exogenous to industry evolution: the nature of institutions affects the evolution of industries, yet the role of firms is largely determined by these environmental dynamics. Murmann (2003) is an exception, as he shows how (and why) firms and industry associations actively aim to moderate the institutional setting, which affects the resourcefulness of their industry. German firms, for example, greatly benefited from the supporting institutions initiated by the government, while British firms simultaneously lost competitive advantage without such support and exchange of expertise between firms and public organizations. Braguinsky and Hounshell’s (2016) work is also important because they offer empirical evidence of the negative role of government in the evolution of the Japanese cotton industry: “[…] the industry took off only after the government terminated its support and intervention policies in 1886” (p. 52). In other contexts, however, Japan has been seen as a positive example (cf. especially Williamson, 1991; Teece, 1992) of such governance and institutional co-evolution that allows the maximizing of economic potential at the firm level.

Part of the complexity surrounding the role of institutions and entrepreneurial nanoeconomics originates in the role of contracts and governance. As the framework that Williamson (2000) proposes, the higher order institutional mechanisms (e.g., norms, habits, laws, statutes, and policies) materialize through contractual arrangements between economic actors. Over time (Argyres & Liebeskind, 1999), these webs of commitment get increasingly complex and affect strategic decision-making and organizational perception (Denzau & North, 1994). For example, the creation of such an arrangement as the Japanese Keiretsu (Gilson & Roe, 1993) or the Korean Chaebol (Campbell & Keys, 2002) would be highly dubious in the modern Western governance environment, but their historical origins explain
their current structures and natures. Accordingly, institutions and the incentive framework (North, 1990) affect entry and exit patterns in at least two ways. First, at the time of firm founding, the entry incentives originate in the institutional setting of the time. This affects the first strategic decisions on market orientation, technology, and institutional positioning (e.g., as a member of financial groups and/or cartels) which over time are imprinted (Sydow, Schreyögg, & Koch, 2009) as the firm’s characteristics (Romanelli, 1991), finally explaining both survival and exit patterns. Second, sudden changes and shocks in the institutional environment or a change or expansion (e.g., in the case of internationalization of business operations) in the institutional environment make the firms susceptible to changing its organizational form. This is an economic and social risk, potentially ending in exit, or these same changes may result in firm exit without any particular transformation period. Examples of the latter kind of selective transformation include the political and geopolitical changes in Germany between 1860 and 1991 (Kogut & Zander, 2000) or those in Russia after 1917 and again in 1991 (Yavlinsky & Braguinsky, 1994). These radical and sudden regime changes affected the social and economic structures of these countries while simultaneously working as powerful selection mechanisms at the industry level. Accordingly, in addition to the above baseline ILC questions, we ask what the role is of institutional evolution and entrepreneurial volition in the entry and exit patterns of the Finnish paper and pulp industry.

**Method**

Our study follows the critical realist (Vaara & Lamberg, 2016) and analytically structured (Rowlinson, Hassard, & Decker, 2014) research tradition in business history and the
historical study of strategy (e.g., Danneels, 2011; Jacobides, 2007). Essentially, we follow Braguinsky and Hounshell (2016) in seeking to:

...illustrate transparently the most important point about the methodology of question-driven research: the enormous gains to be had in building comprehensive nanoeconomic databases and exploiting their analyses [...] the nanoeconomic approach provides the means for scholars in strategy to understand the nature and consequences of strategic choice in industry evolution more fundamentally than is typical using microeconomic analysis on the one hand or purely historico-qualitative analysis on the other. (p. 48)

Accordingly, a nanoeconomic approach means methodologically the study of macro-level industry dynamics from the perspectives of individual firms and entrepreneurs—a choice that creates opportunities for new theoretical understandings and also historically accurate analyses.

Our subject—the Finnish paper and pulp industry—is optimal for the study of nanoeconomics and embedded agency. First, the history and economics of the paper and pulp industry have been studied widely, which means that we had access to a great amount of information on business logic and the evolution of the industry from the beginning of our research (see Appendix 1 for a list of industry-specific literature we used in our analysis). Second, the industry is well documented by contemporary sources such as industry calendars and professional magazines, making it possible to trace chains of events over extended periods. Third, the overall population of the paper and pulp industry firms is simultaneously small enough for a detailed nanoeconomic analysis and heterogeneous enough to yield rich theoretical insights. Finally, due to the highly organized nature of archives and libraries in Finland, we have been able to collect material covering all 98 firms in our database. Table 1 presents the use of these sources per the analytical categories we employed in our research.

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We began our analysis by identifying all the firms that have ever operated in pulp and/or paper production and by building a time series covering the industry evolution embedded in market contexts: entry and exit patterns, efficiency and productivity measures, production figures, and demand for different products. After completing an overview of the industry, we sought information for major technology investments from the magazines Suomen paperi-ja puutavaralehti and Paperi and Puu magazines. These two magazines, published by the Association of Finnish Paper Engineers, include detailed information on new machines, technologies, and investments. It is possible but not likely that some investments have not been reported in the magazines. This is because the firms and especially the technology providers have an incentive to demonstrate that they are technologically on the cutting edge. For example, technology providers might include information in their advertisements, and it is virtually impossible to make large investments in secret due to the high costs and visibility of building projects. Moreover, producers tend to broadcast their scale and scope-increasing investments to pre-empt competitors and to advertise to customers. In addition, we triangulated this information with the database of paper machines in Finland (Lund, 1999) and from heterogeneous sources concerning a few anomalies (e.g., investments that were mentioned in history books in such an ambiguous manner that we could not find exact information on the timing and nature of the investment).

Third, we wrote life histories for all 98 firms, focusing especially on the motivations for entry and exit. This information is typically not listed in industry calendars (the usual source of information in most ILC studies). Our work thus came to resemble that of detectives and historians as we sought information from history books, stock ownership news, local histories, newspaper interviews, and company archives to obtain satisfactory knowledge of the entry
and exit dynamics of the studied firms. The life histories are typically narratives of about one to three pages. They include information on the motivations and pre-entry experience of the founders, the evolution of equity ownership, major strategic changes, links with commercial banks and other institutions, and chronologies and descriptions of exit processes. After we wrote these life histories and the complete series of technology investments, we began coding the variety of motivations for entries and exits. Each firm was coded with one or more entry incentive and exit explanation.

We identified two types of exit: exit by acquisition and exit by dissolution (cf. Fortune & Mitchell 2012). The latter takes place either via filing for bankruptcy or via closing of operations (dissolution). We combined the operational and ownership views of survival (cf. Josefy et al., 2017), and for the purposes of this study survival consists of continuing operations without change in ownership.

To evaluate the role of technology investments in subsequent exit behavior, we chose five technological advancements that have been of great importance in this industry: (1) the transition from sulfite to sulfate process in pulp production, (2) the Kraft process in pulp and/or paper, (3) the supercalender for smoothing the surface of the paper, (4) the newsprint machine, and (5) magazine paper coating. These were chosen after a careful reading of each, discussions with industry practitioners, and ensuring that our data covers their introduction within the firms. All of them are technologies that mainstream companies would need to adopt to remain competitive: 1 and 2 in pulp production, 2 in cardboard production, and 3–5 in paper production. For each company, we traced the years these technology investments were made, or whether they were made at all.
Analysis

*Market environment and entry and exit patterns*

Figure 2 presents the factors that encouraged the firms to enter in different years. Based on the incentives to enter, we can make four observations. First, internal funds were a common entry incentive prior to the Second World War. This means that the initial investment required to begin operations was possible mostly only for entrepreneurs with inherited wealth, wealth through marriage, or wealth accumulated gradually through increasingly large entrepreneurial operations (e.g., from small-time grocery retail to pharmacy to manufacturing of pharmaceuticals to pulp mill). This is a symptom of an underdeveloped financial market, where entrepreneurial ventures were financed mostly by the immediate family. It also means that initial investments were not subject to market selection where the most promising operations would have been funded. Funding was heavily tied to the individual and not so much dependent on the quality of the planned operation.

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The second observation relates to pre-entry experience and social capital, both of which were common entry incentives until the 1920s. Pre-entry experience was comprised of prior industrial operations such as sawmills, ironworks, and prior domestic and international trade activities. Social capital, on the other hand, consisted of local political ties, collusion arrangements among entrepreneurs, relationships with paper machine manufacturers, and business relationships with trade houses in St. Petersburg. The importance of experience and social capital prior to the 1920s indicates the underdevelopment of both upstream and downstream markets. It was difficult, if not impossible, to buy experience in the form of professionals, and therefore entry opportunities were limited to those with experience. The
way in which society was arranged in terms of requiring permits from the Russian imperial establishment for beginning manufacturing operations further limited the population of entrepreneurs able to enter the industry. In ILC studies, it is a common finding that firms with pre-entry experience (e.g., Zheng et al., 2016) or born under favourable founding conditions (e.g., Geroski et al., 2010) are more likely to survive. Our data indicates that in this industry there was no survival advantage for pre-entry experience, but there was a distinctive entry advantage.

Third, we observed that tangible resources and waterpower remained a central entry incentive throughout the history of the industry. These included access to inputs in the form of closely located woodlands, railways, water channels, and hydropower. The necessity of these caused the mills to be scattered across the country because the capacity for wood collection within a comfortable distance from the mill was limited, while hydropower was also limited and under political control. As a consequence, the firms were not able to benefit from cluster dynamics in the form of knowledge flows.

Industrial policy became an important determinant of entry only in the 1930s. Therefore, the Finnish government did not play an active role in the creation of the industry and its technological basis. However, the government-led operations all eventually exited due to the low profitability that was built into their locational and product-mix choices (cf. Braguinsky & Hounshell, 2016 on cotton-milling).

The explanations for exit are presented in Figure 3. Most of the early exits were due to acquisitions in which the buyer was motivated by controlling resources. This means that the firms were not necessarily acquired because of their milling capacity, but rather because of the forests and waterpower they owned. This logic is confirmed by the fact that many
acquired mills were closed shortly after acquisition, and the available wood material was directed to the acquirer’s other mills. Moreover, some acquisitions were made by companies outside the industry, who subsequently closed the mills and focused on operating hydropower and selling the electricity. In the later stages the focus shifted to the buyer’s motivation to control the competitive landscape. This means that buyers wanted to buy off competition in order to control prices. This is, however, not simply a question of aspiring to monopoly, but also a question of economies of scale, especially in export sale operations. Building and operating an international network of sales offices on the margin earned from a single mill’s output is not possible. Therefore, the consolidation was motivated by the internationalization of the industry. This was also a symptom of the development of legislation relating to cartels, which made it increasingly difficult for the firms to collude in pricing from the 1980s onwards.

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From the perspective of the acquisition targets, the inability to invest became an important exit explanation after the Second World War. Certain investments were necessary to remain competitive over the years. These related to both product quality and the cost structure of production. Moreover, tightening environmental legislation made the transition from sulfite to sulfate pulp process practically mandatory. Companies that did not have access to funding or if there was unwillingness to invest for some other reason (e.g., disagreements within the family, death of the founder) were either acquired or closed. Even though the financial markets had begun to function, funding decisions included a component of political control. In many cases, large bank groups made decisions on which mills could continue as independent firms.
Technology investments and exit modes

The charting of entries, exits, and technology investments is presented in Table 2. The table shows the decade during which each firm entered and therefore made their first investment in production capacity (red shade). Thereafter, the increasingly darker blue shades signal each further technology investment. The end of shading for each firm indicates the decade during which the firm exited. The symbols show whether the exit took place via acquisition or closing of operations. Five of these firms continue to operate to this day. There are also three firms for which the exit mode is unknown, and they are excluded from the analysis of exits.

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Based on the table, we can make three observations. First, the investments cluster in certain firms. Of the 98 firms traced, only 37 percent made any further investment after their initial investment at the beginning of production. However, out of those who made the second investment, 47 percent also made the third, and out of those who made the third, 59 percent also made the fourth. The numbers for the fifth and sixth investment are 40 percent and 25 percent, respectively. This indicates that firms were more likely to continue further investment activity than they were to start it.

Our second observation relates to exit modes (see the cross-tabulation in Table 3). There are 21 firms that exited via filing for bankruptcy or closing of operations. None of them made any of the five technology investments. There are 67 firms that exited via acquisition, and 52 percent of them made at least one further investment. It appears that keeping up with competitors in the adoption of new technology does not improve a company’s chances of survival, but it helps a firm to remain a viable candidate for acquisition. Out of the 53 exiting firms that did not invest, 32 were acquired (60%). Out of the 35 exiting investing firms, 100
percent were acquired. Even though a significant number of non-investing firms were acquired, technology investments raised the probability to 100 percent.

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The third observation is about the surviving firms. There still are five firms in operation. Although Stora-Enso, UPM, and Metsä-Group have changed their names and merged several times since the 1990s, they all originate in firms that were large conglomerates in the 1960s and Enso-Gutzeit, Kymi (now part of UPM), and UPM already in the 1920s. All the surviving firms have extensive histories of both technology investments and of acquiring firms that have made technology investments at a prior date. In other words, they have been in the position to choose plants that are technologically at an acceptable level while making heavy investments at the same time. It appears that acquiring firms after the investments have been made may have been a method of managing risk with inherently uncertain new technologies.

**Empirical findings reflected in theory**

In the second section, we proposed a need for complementary theoretical angles to help us understand entry and exit dynamics. However, before we look at our empirical evidence from these complementary perspectives, we return to what is considered standard ILC theory and consider why this established approach to entry and exit dynamics is capable of explaining the macro-level evolution but is less effective in explaining the micro- and nanoeconomics of industry evolution.

*What would ILC theory say?*

On the surface, our data conforms to the ILC theory concerning the first shakeout that took place between the First and Second World Wars. Moreover, we found a survival advantage
for large firms throughout the industry history. However, there was also a second shakeout between 1960 and 1990, and we found that the explanations for exit during this shakeout differed from those during the first one. In the ILC literature, the appearance of multiple shakeouts is explained by sub-markets (e.g., Bhaskarabhatla & Klepper, 2014). This means that each shakeout is caused by the dynamics of the sub-population of specialists. However, in the pulp and paper population, the causes of shakeouts seem to have come from the changing technological and institutional environment. Large size provided an advantage in each shakeout, but the lower limit of acceptable size was much higher in the second shakeout than it was in the first.

However, in the first shakeout the acquisitions were motivated by input resources, such as woodlands, hydropower and manufacturing capacity with railway connections. In the second shakeout, the acquisition motives shifted to price control and economies of scale in export. This also means that technological investments became a more important determinant of acquisition in the second shakeout, because technologically advanced mills formed a threat in price competition whereas technologically inferior mills eventually dropped out of price competition in any case. Therefore, we conclude that Klepper’s argument of price competition and economies of scale causing weaker firms to exit the market and the most efficient ones to survive (survival advantage) should be complemented with the concept of acquisition advantage. By acquisition advantage we refer to the characteristics of the exiting firms that render them candidates for acquisition rather than dissolution. The shakeout process drastically shapes the industry, but what has so far been neglected is the firms that exit through acquisition and hence continue to contribute to the production capacity of the industry.
Exit via acquisition may be the sought-after outcome for an entrepreneur and should therefore not be treated as a failure (Dobrev & Gotsopoulos, 2010). On the other hand, entrepreneurs sometimes delay exit beyond the optimal threshold (Elfenbein & Knott, 2015). It is conceivable that such delays may result in a strong acquisition candidate turning into a bankruptcy filer as the requirements change over time. For example, a company in a good resource position in terms of woodlands and hydropower might have had a strong acquisition advantage in the first shakeout, but an inability to invest in technology destroyed its acquisition advantage by the second shakeout. Therefore, excessive entrepreneurial volition may cause an entrepreneur to miss a window of opportunity and end up in a worse financial position. This confirms the notion that there are many kinds of exits and they should not all be treated equally as failures (Fortune & Mitchell, 2012). From the perspective of the entrepreneur, the survival of the firm is not necessarily the ultimate goal (cf. Josefy et al., 2017).

Overall, while the existing body of literature would be able to predict many of the empirical patterns we may observe, it is unsatisfactory in explaining the nano-level decision-making dynamics aggregating in the familiar shape of the industry life-cycle. The above responses bring us to the role of contracts, institutional shocks and the meaning of entrepreneurial volition in entry and exit dynamics.

**The role of contracts and sub-populations**

An analysis of the evolutionary pathways (entry, exit, and the mode of exit; see Appendix 2) reveals that an important part of exits was not determined by a combination of market dynamics and the capacity to stay in the investment competition. Instead, especially concerning those firms controlled and/or owned by the Finnish government and large
commercial banks, the evolution occurred inside sub-populations. As the financial market was relatively underdeveloped until the late 1980s and the legislation did not prevent banks from owning large shares of listed companies, the *de facto* power to sell, acquire, and merge lay with financial institutions, including the Finnish government. To complement this power structure, Finland was also a prime example of corporate interlocks, resulting in high interdependence inside and between sub-populations. Banks used their power to organize and design the population of Finnish paper and pulp industry companies. For example, the merger between Kymi and UPM in 1996 was preceded by a series of smaller mergers and acquisitions since the early 1980s, first inside sub-populations and then after the two major commercial banks merged, making the merger between the remaining flagship companies possible. The logic for exit decisions was in some cases a result of performance problems, while in other cases the question was purely related to the needs to reorganize holdings.

The merger between Kaukas and Kymmene 1986, on the contrary, aimed to strengthen the commercial bank’s power position and to obtain scale benefits. Similar logic is to be found in the government-owned firm population. Enso-Gutzeit had been the largest of these companies since the 1920s, and decade after decade, the Finnish government merged smaller firms with Enso-Gutzeit. Finally, in the 1980s and the 1990s Tervakoski, Veitsiluoto, and Oulu would have been large enough to survive as independent firms, but the Finnish government wanted to reach the same scale of benefits as in the other sub-populations built around commercial banks and cooperatives. Finally, as the majority of firms belonged to some or several sales cartels until the 1980s and the 1990s, their evolution was to a large degree determined by contractual dynamics (e.g., who produces what and how much) that were beyond the control of smaller firms. Accordingly, the evolutionary mechanisms concerning a
large share of firms were powerfully guided by contracts and interdependencies in sub-populations and cartel agreements.

**Institutional dynamics**

Pulp and paper industry firms and the associations representing their political interests had considerable power to affect the institutional framework in which they were embedded. For example, cartels were either allowed or tolerated (Jensen-Eriksen & Ojala, 2015), industrial self-regulation was both tolerated and supported, and in formative moments of political bargaining (e.g., joining the European Union), the representatives of the paper and pulp industry became a part of the country’s political decision-making system. Also, on a more general level, the institutional setting offered enough predictability and incentives to allow the founding and management of firms in economically viable ways (Acemoglu, 2008). The pulp and paper industry’s evolution was also dependent on institutional dynamics that the industry and its representatives could not predict and/or manage. For example, five firms made an exit between 1939 and 1945 simply because Finland was forced to give up large areas of land in Eastern Finland to the Soviet Union as a result of a lost war and subsequent peace treaty. A few years later, two German firms were first handed over to the Soviet Union and then sold to Enso-Gutzeit. Thus, a considerable part of exit dynamics can be explained by single, large-scale institutional shocks. Similarly, the First World War and legislative changes in Finland catalyzed a wave of exits, as did the process of joining the European Union, which simultaneously meant the end of cartels. A good example of such a process is that of the Leppäkoski paper mill, founded in 1893. Leppäkoski specialized in serving the nearby Russian market, in which Finnish companies had a competitive advantage because they were categorized as domestic producers. This status turned out to be a disadvantage in 1917 when
the Russian Revolution closed the whole market. The product quality of Leppäkoski was not suitable for the markets in UK and Germany, and any improvement in quality would have required extensive investments in more advanced technology. The commercial bank to which Leppäkoski was indebted ultimately took control of the company and sold its equity to the Läskelä Company, which was interested in the available waterpower as well as the new railroad Leppäkoski had built.

Legislation affected entry and exit patterns in more subtle ways as well. Laws limiting the acquisition of forest areas, for example, made mergers and acquisitions a way to circumvent the situation. Similarly, other laws prohibiting and/or making it difficult for foreign companies to start industrial operations in Finland potentially filtered competition (especially concerning raw material supply) and affected both entry and exit dynamics. The number of entries would probably have been higher without investment constraints, and the buffer against foreign competition may have slowed the first wave of exits.

**Nanoeconomics of investment**

Braguinsky and Hounshell (2016) highlight the importance of individual vision and volition in shaping firms and industries. More generally, human volition has been treated as an employee-level concept (Kehr, 2004), but at least implicitly assumed as a necessary condition for entrepreneurial activities. The importance of volition is corroborated by our findings. However, our findings highlight the huge variation across decision-making environments that individuals or groups (e.g., families) face when making similar decisions (e.g., whether to invest in transforming from sulfite to a sulfate pulp process). Initial conditions, decisions made over the years, and relationships with banks and other powerful actors created unique decision-making situations for each decision-making point. Overall, changes in the
technological, institutional, and competitive landscapes drastically changed the value of the collateral each firm owned. The induced causal links between entrepreneurial volition and resource environment (financial resources, knowledge, technology, legitimacy, etc.) aggregate into four quadrants as illustrated in Figure 4 below.

Quadrant 1 is the least complex causal relationship for understanding both entries and exits. For entries, an absence of willingness would not be logical and also our material does not identify any cases in which this condition would exist. For exits, on the contrary, we have cases in which a firm was not able to access the resources necessary for survival and in which the owners were unwilling to continue business operations. An example of this setting is Kissakoski, which was founded in 1907 by a group of entrepreneurs from Helsinki and Viborg. Kissakoski began producing paper in 1910 with one of the largest paper machines of its time. The production of paper ceased suddenly in 1920 when the entire factory burnt down. The owners of the company disagreed as to whether the production facilities should be rebuilt and, as they also lacked capital, the result was to sell the company to Kymi Corporation. More typical cases in Quadrant 1 were traditional bankruptcies in which owners were not motivated to continue the business (e.g., after they had inherited a company or parts of one) and simultaneously banks or other actors in the capital market discontinued financing.

Quadrant 2 is not relevant for explaining entries except in a few cases in which banks forced heirs to continue newly founded businesses. One such example was the Kangas paper mill, which was so heavily indebted after the death of its founder, Gustaf Fredrik Sneckenström, that the banks did not allow his heirs to stop the process of starting production, which still was in its early stages. For exits, the absence of willingness but the presence of resources is
fairly typical among the studied population. For example, the members of the Schauman family sought exit possibilities in the 1980s because they lacked motivation to develop the business. One unrealized alternative was to merge several family-owned companies which all belonged to the same financial group. These other companies (Serlachius and Rosenlew) were acquired by companies outside of the financial group, which motivated the bank (Yhdyspankki) to seek a solution among the companies it controlled. Schauman was ultimately acquired by Kymi Corporation and the family members were able to divest themselves of the business. Other similar examples indicate that exits in Quadrant 2 were typically the results of rational decision-making processes after which owners made a decision to stop investing in the business. For example, Mustio Corporation had technical problems with the adequacy of water resources and decided to stop making mechanical pulp. Similarly, Insulite Corporation—a U.S.-based firm making insulite board—decided to sell its operations due to the Second World War and the potential risks of continuing operations in Finland. Accordingly, in this case an institutional shock was a sufficient cause for the absence of further investments despite the abundant resources of the company.

In Quadrant 3, entries are again non-existing in our data. For exits, however, the condition of lacking resources combined with a willingness to continue business operations is common. A typical example is Jämsänkoski, which was founded in 1888 by two families including a trained engineer Per Köhlin. Jämsänkoski was favorably located in terms of waterpower, forests, and available labor. These factors, in combination with Per Köhlin’s technical expertise, meant the business plan was nearly a good one. Jämsänkoski, however, was distant from any markets and the decision to make unbleached pulp was misguided in terms of the market situation. Six years later the company was in bankruptcy and ended up in the ownership of its largest
creditor, Kansallis-Osake-Pankki. Leppäkoski, Tako, and numerous other companies were among those whose exits included the combination of a willingness to continue business operations with a bank that refused to continue financing these operations. These situations were especially common during and immediately after the world wars as well as in the 1970s and the 1980s when firms faced growing investment burdens due to more demanding environmental regulations.

Quadrant 4, in contrast to the other causal conditions, contained the common explanation for entry. An entrepreneur or group of investors willing to make an entry and able to procure the necessary resources was the typical condition of entry. The allocation of resources, however, was not equal among the numerous entries. Jämsänkoski, which had been established on family assets, struggled financially since its founding while some other entrepreneurs operated with ample resources. A special case is the building of present-day UPM. Rudolf Walden worked as a sales agent before the First World War and started to acquire ownership of many companies at the same time. The process culminated in 1934 when Walden had control of a company that included four entities operating before the war. Walden was clearly a talented entrepreneur and his experience in sales and marketing helped him understand European market dynamics better that most of his peers did. However, he also had unconditional support from a commercial bank that perceived Walden as a mechanism for building an extensive business group. For exits, we found little evidence of conditions combining a willingness to continue investments and available resources. Perhaps the only exceptions were Keski-Suomen Sellulloosa Corporation and Waldhof, a German company. Keski-Suomen Sellulloosa was forced to make an exit after fabricating the purity tests from a lake into which the company had been dumping its wastewater. The company, it
seems, was not lacking in entrepreneurial willingness and it had a relatively good relationship with banks and suppliers yet lost the legitimacy of its operations. Waldhof, on the other hand, was not able to continue its operations as a German company when the Soviet Union took control of it after the Second World War.

To conclude, as our cases suggest, the evolution of the pulp and paper industry in Finland looks different from the perspective of entrepreneurial volition and from that of the nanoeconomics of investments. Technology investments provided no survival advantages. Instead, they served as an advantage in being able to exit through acquisition rather than shutting down operations or filing for bankruptcy. From the perspective of the entrepreneur, shutting down operations with little to liquidate is a miserable outcome. However, encouraging them to invest in order to remain a viable acquisition target would have been ill-advised in many cases. The entrepreneurs faced very different situations when they decided whether to make a specific investment. Each particular decision-making instance was unique because of location, hydropower capacity, availability of wood material, and original technological solutions. For example, an investment may have required a particular production scale to be profitable. If that was beyond the capacity of available hydropower, the company did not invest. It may have had to close once competitors made the same investment and thus changed the competitive landscape. Location also forced many firms to exit by closing operations. As investments lower the unit cost of production, the portion of transportation cost in the final selling price rises. This puts less optimally located mills at a disadvantage, and the decision-makers may conclude that any further investment would be foolish.
Such technological and financial dead-ends are the result of changes in the market environment and beyond the control of individuals. Our results are in line with Braguinsky and Hounshell (2016) on the importance of individual vision and volition, but we would qualify that argument with the effects of the market environment on the opportunities that each individual faces. Moreover, it is possible that volition is affected by domain-specific skills, as suggested by Kehr (2004). It is conceivable that highly skilled entrepreneurs have a larger “volition stock” because their willingness to strive for the company is not depleted by the technical difficulty of the tasks required to keep the company alive.

**Discussion**

The starting point for our research project was the understanding that in some cases (potentially in many) we cannot infer micro-level dynamics from macro-level observations. At the surface level, our study context – the Finnish paper and pulp industry – seems to be one more piece of evidence of the universal power of ILC theory, with its inverted U-curve structure and the survival of large firms constantly improving their efficiency. However, when looking the nanoeconomics of the historical development of the Finnish paper and pulp industry, it becomes apparent that there must be an alternative analytical narrative explaining what we see in the materials we have. While ILC theory would predict the survival of large firms and the exits of small firms during the first shakeout period, the rest of the exit dynamics do not fit conveniently.

Our findings are complementary to earlier research by Argyres and Bigelow (2007), Braguinsky and Hounshell (2016), and Murmann (2013) which all have emphasized the importance of the institutional and contractual environment as a mechanism affecting how
industries evolve over time. We add to these findings in two ways. First, institutional shocks (e.g. the two wars) had a much larger impact than we had predicted. The extreme volatility catalyzed by the shocks was a particular risk for smaller firms specializing in narrow markets, as were sudden changes in regulation. Large firms were in beneficial positions, strengthening the perception of the benefits of size. It is noteworthy that we can demonstrate a direct causal link from changes in the institutional environment to a considerable number of firm exits. The firms that Soviet Union seized are extreme examples yet numerous others were forced to make an exit as a consequence of closed markets and/or lessening demand combined with the financial network’s tendency to re-allocate resources among the firms over which they had control. Second, we identified an institutional setting which channeled evolutionary pressures to contract-based clusters of firms instead of the whole population. Firms that were controlled and/or belonged to a specific network of firms had limited options to make radical transformations, avoid bankruptcies, or become an acquisition target if the bank or governmental agency in power position was opposed. Typically most exits before the 1980s were economically justified but were catalyzed either by contractual or institutional stimuli. Likewise, after the early 1980s, most exits took place because they were dictated by the banks or the Finnish government.

Our focus on nanoeconomics builds extensively on Braguinsky and Hounshell (2016) who focused on the entrepreneurial actions as a causal mechanism explaining the early phases of industry life cycle. We expanded from this starting point in two ways. First, we focused on entrepreneurial volition along the entire life cycle from the emergence of the first companies to the latest phases including only few companies. Accordingly, we have evidence of how and why nanoeconomics affects both entries and exists and to what extent decision-making is
bound by earlier decision-making rounds of the particular firms. Second, we elaborate the concept of entrepreneurial volition by explicating the constraints originating in the resources firms need for survival and potential commercial success. Entrepreneurial volition is needed for entry decisions and for further investment rounds yet the nature and amount of available resources significantly affects the realistic strategies. However, the absence of entrepreneurial volition combined with lacking resources is an important and usually sufficient condition for exits. Accordingly, the concept of ‘nanoeconomics’ expands to explain the how and the why configurations of volition and resource constraints affect the patterns of entries and exists.

Our study also contributes to the recent discussion on the multiplicity of exits (Fortune & Mitchell 2012; Josefy et al. 2017). Exit by being acquired is often a positive outcome whereas dissolution leaves the entrepreneur in a worse financial situation. Dissolution certainly gives the entrepreneur the opportunity to liquidate the assets of the firm, but selling an operating paper mill as a firm usually gives a better return than selling the outdated machinery for scrap metal. We introduced the concept of acquisition advantage parallel to survival advantage to describe the attractiveness of a company as an acquisition target. However, excessive entrepreneurial volition may cause an entrepreneur to decline acquisition proposals and hence miss the window of opportunity for profitable exit (cf. Elfenbeim & Knott 2015).

The multiplicity of exits also opens a new avenue for industry life-cycle studies (e.g. Klepper 1996, Klepper 2016). At the core of the ILC theory is the reallocation of market shares to the more efficient firms in the shakeout stage. Exits via acquisition or dissolution have different roles in this process: the physical and intellectual assets of acquired companies continue to
contribute to the production capacity of the industry whereas those of the dissolved companies truly exit the industry.

**Limitations**

All of the above-mentioned phenomena confirm the importance and further contribute to the understanding of the nanoeconomics of industry evolution (Braguinsky and Hounshell 2016; Klepper 2016). However, our study is also not without limitations. Our theorizations build on data from a small country and from historical institutional settings. However, the selection of this country allowed as to trace all the firms to a level of detail that might not have been possible for larger countries. Moreover, several of global leading companies of this industry originate from our population. The institutional settings are historical, but the importance of institutional barriers (Chang & Wu 2014) and political ties (Zheng et al. 2015) is a continuing phenomenon globally.

Our observations are from a manufacturing sector and that raises the question of generalizability to service sector. Many services, however, require investments into physical assets which may give rise to similar dynamics relating to ties to financiers, investments required to stay abreast with competition and entrepreneurial volition to stay in the race.
References


Figure 1. Entries, exits and firm numbers.
Figure 2. Entry incentives.
Figure 3. Exit incentives.

- Buyer: Control resources
- Buyer: Control competitive landscape
- Seller: Unable to invest
- Seller: Family trouble
- WW1, WW2, Force majeure
**Figure 4.** Induced causal links between entrepreneurial volition and resource environment.

<table>
<thead>
<tr>
<th>Resources</th>
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<td><strong>Absent</strong></td>
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| Quadrant 1 | Entry: not logical  
Exit: especially bankruptcies and forced disbandings. |         |
| **Present** |        |         |
| Quadrant 2 | Entry: theoretically possible but absent from our data.  
Exit: cases in which families decide to make an exit due to missing or low motivation to continue ownership / operations. |         |

| Quadrant 3 | Entry: theoretically possible but absent from our data.  
Exit: cases in which an institutional shock, overly expensive investment, and/or banks’ unwillingness to continue financing result in an exit. |         |
| Quadrant 4 | Entry: typical condition for an entry.  
Exit: some cases exist in our data in which entrepreneurs and/or management would be willing and able to continue in the business yet are forced to a merger by financial groups or authorities. |         |
Table 1. Data sources.

<table>
<thead>
<tr>
<th>Data items</th>
<th>Primary source</th>
<th>Secondary source</th>
<th>Tertiary source</th>
<th>Quaternary source</th>
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<td>Local histories, newspapers, and/or archival catalogues.</td>
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<td>Entry incentives</td>
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<td>Exit modes</td>
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<td>Newspapers, related literature, and other sources.</td>
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<td>Local histories, newspapers, and/or archival catalogues.</td>
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<td>Company histories and dedicated platforms on the Internet (e.g., <a href="https://fi.wikipedia.org/wiki/Suomen_paperiteollisuus">https://fi.wikipedia.org/wiki/Suomen_paperiteollisuus</a> and <a href="http://www.historyofpaper.net/paper-history/paper-machine-history/">http://www.historyofpaper.net/paper-history/paper-machine-history/</a>)</td>
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*Paperbase database is a searchable database of historical Finnish companies.
Table 2. Entries, exits, and technology investment activity.
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Table 3. Cross-tabulation of investing/non-investing firms and exit modes.

<table>
<thead>
<tr>
<th>Exit mode</th>
<th>No further investments</th>
<th>Investments</th>
<th>Total</th>
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<td>Exit by bankruptcy</td>
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<td>0</td>
<td>23</td>
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<tr>
<td>Exit by acquisition</td>
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<td>35</td>
<td>67</td>
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<tr>
<td>Exit mode unknown</td>
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<td>0</td>
<td>3</td>
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<tr>
<td>Survive</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>36</td>
<td>98</td>
</tr>
</tbody>
</table>
Appendix 1: Literature used in the historical analysis


Annala V., Tervakosken paperitehtaan historia. Helsinki 1956. 379 s.


Huovila, Marja et al. (toim.): Waldhofin aika Käkisalmessa: puu nosti, sota tuhosi. Heinola: Käkisalmi Serla.


Kuusankoski, Stromdal 1996.

Kuusankoski: Käsikirjoitus, Kymin keskusarkisto.


Kuusankoski, Stromdal 1996.

Kuusankoski: Käsikirjoitus, Kymin keskusarkisto.


Kuusankoski, Stromdal 1996.

Kuusankoski: Käsikirjoitus, Kymin keskusarkisto.


Kuusankoski, Stromdal 1996.

Kuusankoski: Käsikirjoitus, Kymin keskusarkisto.


Kuusankoski, Stromdal 1996.


Virtanen, Sakari, Yhtiöstä yksiköksi, UPM Kajaani 100 vuotta. UPM, Kajaani. 2007.


Appendix 2: Genealogy of the firms.

Key

- **State-owned**
- **Partially state-owned**
- **Bank-owned**
- **Bank- and state-owned**

1818

- **Tervakoski**
  - 1818

2016

- **Hackman & Co., Cellulosa Fabriken**
  - 1866

- **Enso**
  - 1889
  - 1926
  - 1941
  - 1984

- **Sunila Osakeyhtiö**
  - 1928

- **Oulu Osakeyhtiö**
  - 1935

- **Kemijärven Sellu... Boards Oy Ltd**
  - 1903

- **Enso Träsliperi**
  - 1889
  - 1926
  - 1941
  - 1986
  - 1991
  - 1968
  - 2009