

If the state is incompetent, do it yourself: private alliance as an institutional architect in the catch-up process

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We examine the Finnish pulp and paper industry's century-long catch-up journey, focusing on the intertwined development of technical and institutional capabilities. Using historical methods, we highlight how a private, self-organized R&D alliance evolved into an institutional architect, ultimately shaping not only governance but also regulation and entire innovation systems. Our findings demonstrate that sectoral systems of innovation emerge from both technological advancements and from private actors crafting adaptive institutions. The role of private actors is critical when governments are incapable of formulating and enforcing industrial policy. Overall, we propose that substantive experts contribute not only to technical but also to institutional capability.

JEL Classification: D23, L24, O32.

1. Introduction

How latecomer countries catch up to their international competitors is a foundational question in the history of economic development (Gerschenkron, 1962; Chandler, 1969; Abramovitz, 1986; Amsden, 1992; Malerba and Nelson, 2011). The literature on catch-up has revealed windows of opportunity, learning from more advanced nations, and the interaction of capability building and institutional development as its main pathways (Lee and Ki, 2017; Perri et al., 2017; Figueiredo and Cohen, 2019; Malerba and Lee, 2021). Particularly important are the fine-grained contextual mechanisms by which catch-up occurs over time: “[E]ach country does things in a different way, as a result of an indigenous process of learning” (Malerba and Nelson, 2011: 1647). Furthermore, the role of public actors, such as the state, in late development remains both elusive and contested. Gerschenkron (1962) famously emphasized that the role of the state was essential in orchestrating development in situations of significant industrial backwardness of the focal country. However, as Kasza (2018) and others (e.g., Braguinsky and Hounshell, 2016) have proposed, the importance of the state depended not only on the degree of backwardness but also the nature of the industries in question. For example, whether the industry trying to catch up is labor- or capital-intensive is pertinent because it has implications for various state interventions, such as protectionist policies, subsidies, and state investments (Amsden, 1992).

In an attempt to understand the fine-grained contextual mechanisms and the institutional environment in which catch-up within a specific industry occurs (Welch *et al.*, 2020), we combine historical methods with theories of organizational economics to analyze the indigenous evolution of the Finnish pulp and paper industry from 1916 to 2009. In these 93 years, the industry caught up with the international competition, and it also produced some of the largest global incumbents, such as Stora Enso and United Paper Mills (Ojala *et al.*, 2006; Lamberg and Peltoniemi, 2020). We seek to make sense of how this happened.

In our analysis, we focus on the industry-wide organization of R&D, which echoes Malerba and Nelson's (2011: 1648) observation that catching up tends to occur at the level of *sectoral systems*. Within these sectoral systems, R&D laboratories prominently feature in the catch-up literature as actors that engage in basic and applied research (Mazzoleni and Nelson, 2007), generate engineering knowledge (Kim and Lee, 2015), transfer knowledge (Murmman, 2003), and ultimately, encourage a broad array of firms to seek technological improvements (Mathews, 2002). Acknowledging the relevance of the technical drivers of catch-up, we also emphasize the design and maintenance of an institutional environment to complement the technological advances. In the case of the Finnish pulp and paper industry, catching up was a matter of both technological competence and institutional development. Insofar as the latter was concerned, the Republic of Finland, a nascent nation that had just gained its independence from the Russian Empire, was simply incapable of providing the kind of institutional support theories of late development tend to assume as essential (e.g. Gerschenkron, 1962).

The catch-up process of the Finnish pulp and paper industry is interesting because both the technological development and the institutional development were spearheaded by a self-organized collective of private organizations. Indeed, even in the case of institutional development, the role of public actors was limited to providing the private collective the mandate to morph the institutional environment. For this reason, we find it important to elucidate the process by which a weak state in conjunction with a heterogeneous population of relatively small firms first self-organized to compensate for both institutional and technological deficiencies, and subsequently, how the strengthening of both the state capacity to formulate and enforce industrial policy and the competitiveness of the larger firms ultimately rendered the industry-wide R&D alliance obsolete. The public actor exercised oversight, but the central substance for regulation, even legislation, in the Finnish pulp and paper industry originated in the private collective.

Because maintaining the government mandate was central, the technological aspects of catch-up had to be complemented with efficient governance structures. Private actors engaging in shaping the institutional environment is always a cause for concern due to the potential mismatch between public and private interests. We submit that in the case of the Finnish pulp and paper industry catch-up process, the mismatch was avoided by maintaining efficient governance structures, that is by directing attention both to *ex ante* alignment and *ex post* adjustments (Reuer *et al.*, 2002; Faems *et al.*, 2008; Ness, 2009; Ketokivi and Mahoney, 2023).

Our research contributes to a more nuanced understanding of the variety of roles that R&D alliances can have in catch-up processes. These roles extend beyond technological development to safeguarding transactions, creating industry self-regulation, developing standards, providing education, and even impacting legislation. More generally, we provide insight into the relationship between governance and the institutional environment and, specifically, how governance impacts the institutional environment. While the ways by which the institutional environment imposes constraints on governance are comparatively salient, the ways by which governance can impact the institutional environment remain elusive (Williamson, 2000: 596). Our focus on multiple levels is consistent with Malerba and Lee's (2021: 987) prescription that "catch-up should be studied at several levels, such as the firm, sector, region, and national levels." Our analysis incorporates all these levels reporting a complex coevolutionary process of market structure and institutional context—from a weak state and fragmented industrial organization to interventionist industry policies and an oligopolistic market structure with few self-standing firms.

2. Institutions, technology, and governance as the foundations of catch-up

2.1. Catch-up in technology and institutions

The dual role of technology and the social environment (institutions) in which it is developed is well established in the catch-up literature. A case in point, [Abramovitz \(1986\)](#) considered catch-up as technological modernization aided by *social capability*. By social capability, [Abramovitz \(1986, 388\)](#) referred to the “political, commercial, industrial, and financial institutions,” implying that the primarily level of analysis is the country. The focus on state agency is common: Theories of catch-up often highlight the central, proactive role of public actors, emphasizing their “assertive economic role” and economic development that is essentially “state-driven” ([Kasza, 2018: 147](#)).

But what if the requisite institutional capabilities are either deficient or altogether absent? We propose that in the context of weak or developing institutional regimes, catch-up must simultaneously tackle the three challenges of technical, organizational, and institutional development. To use [Williamson’s \(2000\)](#) terms, crafting order, mitigating conflict, and realizing mutual gains extends beyond the technical aspects to interorganizational governance, and even to setting the “rules of the game.” The fundamental challenge lies in the fact that the state (and the relevant public actors) does not have the requisite capability.

The Meiji Era Japanese cotton-spinning industry offers a cautionary tale. [Braguinsky and Hounshell \(2016: 47\)](#) described the interventions by the Japanese government as “authority not backed by competence.” This led to outcomes that were considered worse than no intervention at all would have been. Critically, the effects of poor institutional capabilities spilled over to the development of technical capabilities as well. Public actors in Japan sometimes ended up promoting “deeply flawed technologies” such as the use of hydro power, which created problems for the manufacturers ([Braguinsky and Hounshell, 2016: 49](#)). Of all the government-promoted firms in Japan, “only few were even temporarily successful.”

Beyond state agency, catch-up processes have been examined from three perspectives. One focuses on windows of opportunity ([Figueiredo and Cohen, 2019](#)). These windows are opened by various disruptions, such as the emergence of new technology, economic downturns that make investments more attractive, shifts in demand and changes in institutions and policy ([Lee and Ki, 2017](#); [Lee and Malerba, 2017](#)). Windows of opportunity not only enable new entrants to the market but they also may result in challenging and even replacing the incumbents. [Figueiredo and Cohen’s \(2019\)](#) study of the Brazilian pulp and paper industry is a representative example in this stream of research.

The second perspective examines how countries learn from one another ([Chandler and Hikino, 1997](#); [Perri et al., 2017](#)). Multinational enterprises, foreign direct investments, R&D laboratories, and individual-level knowledge networks have been identified as conduits through which less developed nations learn from the more advanced ones ([Murmman, 2003](#); [Perri et al., 2017](#)). Whether the recipients are able to exploit the transferred knowledge depends on their absorptive capacity ([Borensztein et al., 1998](#)).

Our research resonates most strongly with the third perspective, which emphasizes the interactions and complementarities between technological competence and institutional development ([Malerba and Lee, 2021](#)). As to the latter, attention turns to national and sectoral *innovation systems* ([Malerba and Lee, 2021: 986](#)). Here, the enduring challenge is that while technological aspects are comparatively salient, the systemic aspects are elusive. [Abramovitz \(1986 388\)](#) noted that insofar as social capability is concerned, “no one knows just what it means and how to measure it.”

However, the literature offers some useful approaches to social capability. The concept of an *innovation system* is well established, particularly at the sectoral level. Sectoral systems of innovation consist of various actors, such as firms, governments, local authorities, universities, and R&D laboratories, as well as institutions, such as legislation, regulation, and industry standards ([Malerba, 2002](#)). It is similarly well established that many sectoral institutions arise through actors interacting within the system and that both market and organizational failures give rise to policy interventions ([Stiglitz, 1989](#)). Effective innovation systems provide foundational support to technological capability-building at the country level ([Wengenroth, 1997](#); [Malerba and Lee, 2021](#)).

The literature contains several illustrative examples of R&D organizations as engines of catch-up, both at the country and at the individual sector levels. In Taiwan, government-initiated consortia of public research institutes and companies have resulted in the “rapid adoption of new technological standards, products or processes developed elsewhere, and their rapid diffusion to as many firms as possible” (Mathews, 2002: 635). In Brazil, China, India, and Korea, governmental research institutes have developed standard technologies through public procurement contracts (Lee *et al.*, 2012). Interfirm R&D collaboration has resulted in both R&D cost reductions and synergies by accessing complementary capabilities (Lee *et al.*, 2010). Industry-wide collaborations with companies and public R&D labs have also resulted in leapfrogging global leaders (Figueiredo and Cohen, 2019). Especially application-oriented research laboratories have contributed to the accumulation of technological capabilities in various sectors and countries (Mazzoleni and Nelson, 2007). The role of R&D organizations in technology development is well established, but their role in contributing to the institutional development crucial for catch-up has so far received less research attention. Also, in line with the classic studies on catch-up mechanisms (Gerschenkron, 1962; Amsden, 1992) in each of these examples the assumption is that the state—in one role or another—is a central mechanism of action. As McCraw (1997: 537) pointed out in the case of United States industrialization, “policy makers systematically designed a fertile setting for private entrepreneurship, a greenhouse for business.”

2.2. Governance as a mediator in catch-up

Following recent examples (e.g. Cantwell *et al.*, 2015), we propose that the key to understanding the link between technological and institutional (social) capabilities requires an understanding of how the catch-up processes are governed. We further suggest that the role of governance is crucial as it mediates the relationship between the institutional environment and technological development. Williamson’s (2000; see also North, 1990) multilevel schema of institutions and the various orders of economizing helps us crystallize this mediating role (Figure 1).

Applying Williamson’s schema, we frame social capability as *first-order economizing* where the purpose is “to get the institutional environment right” (Williamson, 2000: 597). Technological development, in turn, can be construed as a matter of resource allocation and about “getting the marginal conditions right” (Williamson, 2000: 597); this is *third-order economizing*. Governance represents *second-order economizing* and falls in between the other two. In second-order economizing, the objective is to “[g]et the governance structures right” (Williamson, 2000: 597).

In the context of sectoral and national catch-up processes, the relevant questions are about how the processes of technology development are governed, how joint R&D activities are organized, who is involved, what the roles of public and private actors are, who exactly owns the central technological competencies, and who exercises oversight over their distribution and application. In second-order economizing, attention turns to the “governance of contractual relations” where the term *governance* refers to “an effort to craft *order*, thereby to mitigate *conflict* and realize *mutual gains* (Williamson, 2000: 599). In our empirical analysis, we seek to establish that governance (organizational) capability is just as relevant as social (institutional) and technological capabilities, and that the three are strongly complementary.

3. The empirical context: the Finnish pulp and paper industry

Our empirical analysis examines the evolution of the Finnish pulp and paper industry over a 93-year period from 1916 to 2009. The case offers a detailed and nuanced illustration of the interplay between technological development and institutional morphing. Most importantly, it emphasizes the role of efficient governance as a mediator over an entire catch-up cycle from an underdeveloped industrial producer to a leading cluster of producers and technological knowhow (Järvinen *et al.*, 2012). A year before Finland’s declaration of independence in 1917, a group of Finnish industrialists contemplated how to lay the foundation for a strong industrial base for the soon-to-be-independent country. Competition was construed mainly as a national and a sectoral issue: How could Finnish industrial firms catch up with, and successfully compete against, international rivals? How could they gain access to international markets?

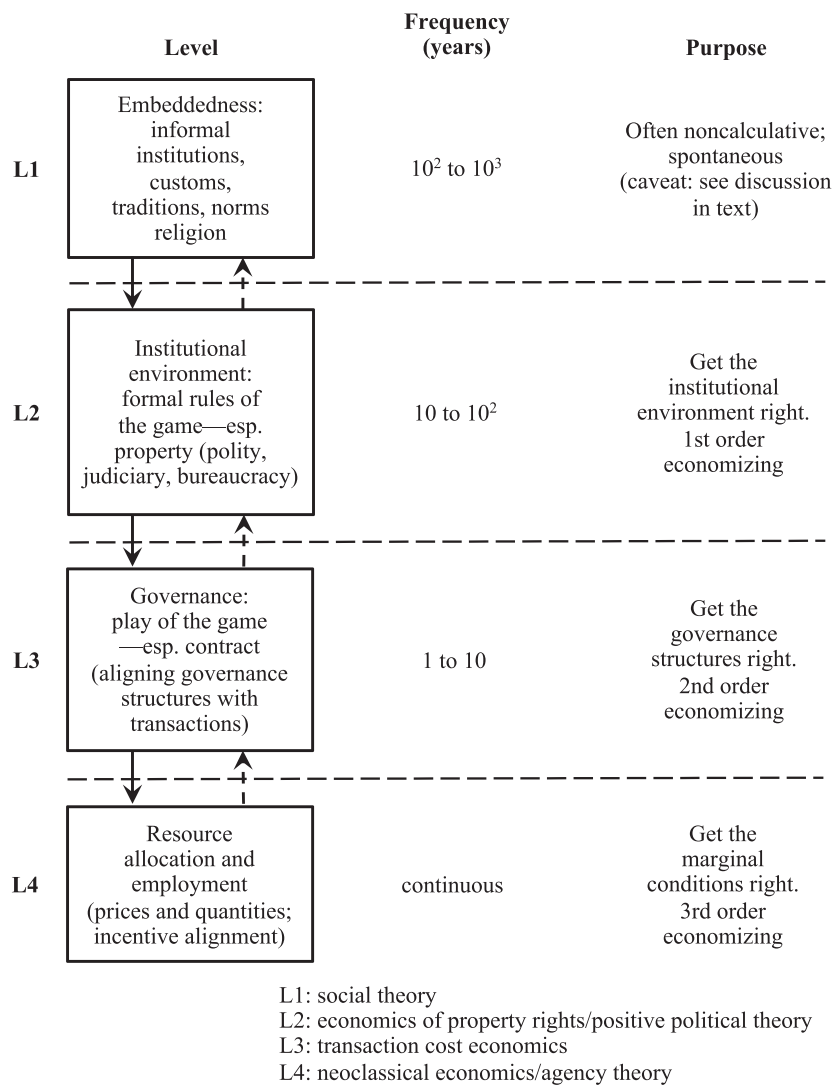


Figure 1 Williamson's (2000) schema for social analysis (Copyright American Economic Association; reproduced with permission of Journal of Economic Literature and the estate of Oliver Williamson)

The group of industrialists concluded that the first step was to establish a joint R&D organization in the field of chemical research and industry applications. To the end of consolidating, developing, and leveraging technical expertise scattered across and within industries, the Central Laboratory (known through its Finnish-Swedish abbreviation KCL) was founded as a joint-equity venture. All the central industrial corporations for whom chemical research was relevant eventually joined the venture.

KCL's 1916 original Articles of Incorporation describe KCL's purpose succinctly: "The aim of [KCL], a limited-liability company founded for the purpose of public benefit, is to engage in chemical research and experimentation to serve industry interests. The company will establish and maintain its own research laboratory. The company may also conduct research and experimentation activities and exercise oversight over the introduction of new production methods in its member firms." In the 1919 amendment to the Articles, KCL was explicitly designated as a nonprofit organization: Whatever surplus KCL's activities produced would be invested in its entirety to further developing KCL.

In governance terms, the three issues and the associated governance choices are matters of *ex ante* alignment: designing a formal governance structure that aligns with the characteristics of the key

relationships. In the case of KCL, the key relationships are two-fold. One is the set of relationships between the venture partners themselves; the other is the relationship between the joint venture and the institutional environment. In both dimensions, the objective of *ex ante* alignment was to establish KCL's credibility in the eyes of all those whose cooperation was required for KCL to successfully achieve the objective specified in its founding documents.

In the detailed empirical analysis that follows, we turn attention to *ex post* adjustments, the dynamic counterpart of *ex ante* alignment: how did KCL's technological scope evolve over time? When and in what ways did KCL become an institutional architect? What were the corresponding adjustments in KCL's governance by which KCL sought to maintain credibility in the eyes of its members and the institutional environment? We submit that while initial conditions matter and set the stage for further development, KCL's story is ultimately a story of adaptation, described by Williamson (1996: 31) as "the central problem" of economic organization.

4. Key actors, data sources, and analysis approach

4.1. Key actors

The coevolution of KCL's governance and the institutional environment involved a broad array of actors, such as industrial firms, industry associations, sales cartels (which were legal throughout much of KCL's history), political institutions, and influential individuals and families. An overview is provided in Table 1.

The empirical analysis draws on an extensive collection of mainly private documents from KCL and other relevant organizations' internal archives. In addition, we used two supplementary sources of data: various monographs such as retrospectives and memoirs written by KCL insiders and industry experts that addressed KCL's history and Finnish industrial history more generally and interactions with KCL's former executives, board members, and industry experts to seek additional insights. Each category is given a code to reference it in the analysis. The data sources and codes are summarized in Table 2 and described in the following.

4.2. Data sources

4.2.1. Official documentation

KCL's and the cartels' articles of association [OD1] and KCL's six editions of corporate bylaws [OD2] detail the institutional arrangements and the foundation of KCL's governance. In addition, 93 volumes of annual reports [OD3] chronicle the key organizational aspects and events in more detail. Annual reports provide information on KCL's critical assets, particularly capital investments. The materials not available publicly were obtained from KCL's corporate archives, to which the lead author gained access. The cartels' articles of association are publicly available through the Central Archives for Finnish Business Records.

4.2.2. Internal archival material

Two categories of internal documents are relevant to our inquiry: confidential [CD] and published [PD] documents. The former includes documents such as minutes of shareholder meetings [CD1] and board meetings [CD2], which gave us a granular look at the dynamics of KCL's governance and decision-making. In addition, we obtained minutes of meetings of KCL's Research Committee [CD3] and Technical Committees operated by the cartels [CD4]. We also had access to confidential internal research reports such as the *KCL Research Report* [CD5] and the internal newsletter, *KCL Circular* [CD6]. Indeed, KCL's board of directors considered these internal documents—*KCL Research Report* in particular—as KCL's primary output. These proprietary documents contained information on how KCL allocated resources to its activities, which gave us a firm grasp of the dynamics of KCL's scope over its history.

KCL produced some of its documents internally but with the explicit intent of publication. We had access to KCL's annual publications [PD1] that, for example, documented standardized analysis and testing methods that KCL had developed to promote the methods broadly in the industry. These

Table 1 The “cast of characters”

Entity (organizational form)	Role	Specific organizations or individuals, with a shorthand name in parentheses
(1) Industrial firms (LLC, cooperatives)	Developed, produced, and sold pulp and paper products; the majority belonged to (2) and (3).	Kymmene, Myllykoski, Nokia, United Paper Mills, Stora Enso, Tampella, and dozens of others
(2) Forest products associations (for-profit cooperative)	Cartels that coordinated primary sales and marketing but also some production activities of (1)	Finnish Paper Mills' Association (Finnpap) Finnish Cellulose Union (Finncell) Finnish Board Mills Association (Finnboard)
(3) Industry associations (advocacy NGO)	Lobbied politicians and advocates industry-wide standards on behalf of (1) and (2)	Central Association of Finnish Wood-working Industries (the Federation)
(4) The alliance (joint equity LLC)	Conducted activities under the ownership of (1) and under the direction of (1), (2), and (3)	The Central Laboratory (KCL)
(5) Influential individuals	KCL's founding fathers	Alfthan, Aschan, Elving, Klingendahl, Ramsay, G. Serlachius, Walden, Wegelius
	Influential families	Alfthan, Ahlström, Ehrnrooth, von Freneckell, Haarla, von Julin, Rosenlew, Serlachius, Sumelius, Walden
	Interlocked individuals	Kotilainen, Ramsay, Walden
	Notable shareholders	Klingendahl
	Notable board members	Aschan, Ekholm, Enckell, Fogelholm, Honkajuuri, Klingendahl, Langenskiöld, Ramsay, Rosenlew, G. Serlachius, R. Serlachius
	Notable managing directors	Bergman, Jensen, Mannström, Nybergh
(6) Political institutions (agencies of the executive branch of government)	Ad hoc agencies of the Finnish Government that directed industrial policy and production during WWII	Economic Council of National Defense, before WWII Department of State Welfare, during WWII War Reparations Committee, after WWII
(7) Intergovernmental organizations and agreements	Coordinated and harmonized economic activities, political decision-making, and trade policy across European countries	European Free Trade Association (EFTA) European Economic Community (EEC) European Union (EU)

Table 2 Summary of data sources and codes

Data source	Subcategory	Code
1. Official documents (ODs), mainly internal archival material	Articles of association (cartels)	[OD1]
	Articles of association (KCL) (1916, 1948, 1960, 1970, 1976, 1981, 2003, 2013)	[OD2]
	Annual reports (KCL) 93 volumes	[OD3]
2. Internal archival material, both confidential documents (CDs) and published documents (PDs)	Minutes of shareholder meetings (approx. 200)	[CD1]
	Minutes of board meetings (approx. 200)	[CD2]
	Minutes of meetings of KCL's Research Committee 117 meetings in period 1971–2009	[CD3]
	Minutes of meetings of the technical committees 670 meetings in period 1927–1990	[CD4]
	<i>KCL Research Report</i> , confidential research reports 2947 issues in period 1931–2009	[CD5]
	<i>KCL Circular</i> , a confidential internal newsletter 1788 issues in period 1920–1991	[CD6]
	Minutes of meetings of KCL Financing Committee 1971–2003 (40 meetings)	[CD7]
	Minutes of meetings of KCL Executive Committee	[CD8]
	Standardized analysis and testing methods intended for broader use, 50 annual publications starting in the 1930s	[PD1]
	149 patents in period 1917–2009	[PD2]
	<i>KCL Communications</i> , public research reports 598 issues in period 1917–1990	[PD3]
	Yearbooks by the Finnish Forest Products Engineers' Association 66 volumes in period 1927–2014	[PD4]
	Annual reports by Finncell and Finnapp	[PD5]
	Memoirs and other historical retrospectives authored by KCL's insiders; cartel histories	^a
3. Supplementary: other published monographs		
4. Supplementary: interactions (SI)	Interactions with former board members	[SI1]
	Interactions with former and current executives	[SI2]
	Interactions with technical experts	[SI3]

^aThe supplementary monographs are referenced in the article using conventional referencing (author, year) instead of bracketed codes.

publications are helpful in developing an understanding of KCL's quasi-regulatory role, as well as the scope and substance of KCL's research work. Moreover, KCL's patents [PD2] summarize its intellectual property.

4.2.3. Published monographs

Of particular importance are five retrospectives written by KCL's insiders: Bergman (1928), Grönvik (1966), Laamanen (1991), Magnusson (1996), and Levlin (2010). These comparatively contemporaneous descriptions by individuals who participated in KCL's management opened a unique window into what KCL's leaders considered important. Of importance are also the cartel histories (Koskinen, 1968; Laiho, 1998; Heikkinen, 2000; Jensen-Eriksen, 2017), and books that chronicle the history of the Finnish forest industry (Kuisma, 2006; Aunesluoma, 2007; Jensen-Eriksen, 2007; Lamberg *et al.*, 2012).

4.2.4. Supplemental interactions

Throughout the research process, we engaged in informal conversations with KCL's former executives, board members, and technical and scientific experts. The purpose of these interactions was threefold. One, we wanted to ensure that our interpretations, developed primarily based on archival material, resonated with KCL insiders. Two, the insiders helped guide us to the relevant archival material. For example, if we had a question regarding a particular technology developed at KCL or the motivation behind establishing a new research department or a particular governance decision, our contacts pointed to the specific archival source where we could find more information. Executives and board members also provided us with additional insights on detailed scope and governance issues. Finally, several KCL insiders also reviewed earlier versions of this manuscript and offered comments and clarifications.

4.3. Analytical approach

Our work joins the historical turn of organizational research (Kipping and Üsdiken, 2014; Vaara and Lamberg, 2016). The study of history is particularly useful in elucidating complex evolutionary phenomena such as the multidimensional and multilevel dynamics of firms, industries, and the institutional environment (Augier and Teece, 2025). More specifically, our research aims for a contextualized explanation (Welch *et al.*, 2020) of theoretically grounded observations or in other words, “history in theory” (Kipping and Üsdiken, 2014: 535) where “history or the past are part of the theoretical model itself as a driver or moderator.”

We began our analysis by creating a macronarrative of key events (cf. Langley, 1999). The function of this narrative was mainly descriptive: to gain and communicate an understanding of the main events, decisions, disruptions, and reactions to the disruptions. To this end, we created a timeline of changes in KCL's scope, governance, and the institutional environment. To enable a detailed analysis of KCL's scope, governance, and the institutional environment, we divided the macronarrative into four time periods. Langley (1999: 696) notes that defining “temporal breakpoints” is an essential analytical tool when one faces eclectic historical data. Most importantly for the purposes of our inquiry, temporally bracketing KCL's history helps us structure the central catch-up process and KCL's role in it. Therefore, the four historical phases are offered both as historical and analytical categories. Finally, because the institutional environment is central to the catch-up process, temporal bracketing incorporates not only the evolution of KCL and its member firms but also the institutional environment. The 93-year timeline and the four time periods are summarized in Table 3.

After creating the macronarrative and the temporal brackets, we analyzed KCL's internal dynamics in detail. This entailed an examination of KCL's funding, organizational structure, and microlevel governance decisions such as board composition. Central to this was the analysis of the dynamics of KCL's scope: in what activities was KCL involved, during what time periods, what were the most significant scope changes, and what was their objective? Table 4 gives a summary of KCL's activities in the four periods and Figure 2 presents KCL's departmental structure.

5. Empirical analysis

5.1. Period I (1916–1943): toward standardization

5.1.1. Historical context

In early 1916, 15 individuals founded KCL (Grönvik, 1966). The first board comprised 13 members, including shareholder representatives—wealthy industrialists—and experts such as university professors, politicians, and industry specialists. Over the next 2 years, KCL raised additional capital from new shareholders to acquire laboratory equipment. All funding was private, as the Finnish government opted not to support the initiative. In 1923, the cartels acquired the remaining issued but unsubscribed shares. From 1920 onward, specific associations began providing annual grants to KCL [OD3].

The founding of KCL was far from routine. In 1916, Finland was among the poorest countries in Europe, predominantly agrarian, and its nascent industries—developed in the late 19th century—were competitive only in domestic markets, which included Russia, as Finland was a part of the Russian

Table 3 The four periods of analysis

	1916–1943: toward standardization	1943–1972: from laboratory-scale to industrial-scale research	1972–1996: from industry-level to corporate-level strategies	1996–2009: toward industry consolidation
Institutional environment	Finland declares independence from Russia in 1917 Emerging economic institutions and foreign policy Nationalistic and protectionist economic policy; centralized systems of trade; industry-wide production and sales cartels	Strong national industrial policy due to war reparations; significant state intervention; centralized resource allocation Economic institutions more established; increasing bureaucracy Rapid economic growth	Corporations gain prominence as cartels disappear; industry consolidation Financial deregulation allows geographic expansion Finland enters into an agreement with the European Economic Community in 1973 Harmonization of economic legislation and regulation within Europe; elimination of tariffs	Finland joins the EU in 1995 Industries are highly concentrated Increasing antitrust concerns; cartels become illegal
Corporate environment	Russia as the main market dwindles Strong pressures to enter new markets (mainly in central Europe) International competition intensifies	Meeting the rapidly rising demand for pulp and paper products in postwar Europe becomes the central strategic concern	Shift from industry- to corporate-level strategy Organizational scope shifts from being large domestic export corporations to multinationals with an international presence	Digitalization leads to a drastic decrease in the demand for printing paper, forcing fundamental reallocation of resources to new products
Technological environment	Industrial standards emerge to support export and international trade	Intense pressure to expand production capacity, improve productivity, and seek new materials and products	Leaps in process technology Environmental concerns become prominent	Advances in product technology (e.g. bioproducts)
Main economic actors	Wealthy industrialists who founded and spearheaded KCL and were active in the cartels, the Federation, and the industrial firms	Cartels and the Federation, both supported by all major corporations in the industry as well as the industrialists and their families	After substantial, industry-wide acquisitions, nine consolidated corporations remained	Seven consolidated corporations
Firms	60 → 42	42 → 31	31 → 9	9 → 7
Entries	19	7	3	1
Acquisitions	27	7	23	3
Dissolutions	10	11	2	1

Empire until 1917 (Hjerpe, 1989). While Finnish legislation and institutional infrastructure resembled those of Sweden and Germany, the government's role was limited to various "night-watchman" functions, largely due to resource constraints (Tiihonen and Tiihonen, 1984). During the First World War, the government focused on alleviating food shortages, and in 1918, Finland experienced a civil war between the "Reds" and the "Whites." The victory of the "Whites" ensured the continuation of capitalism, but it

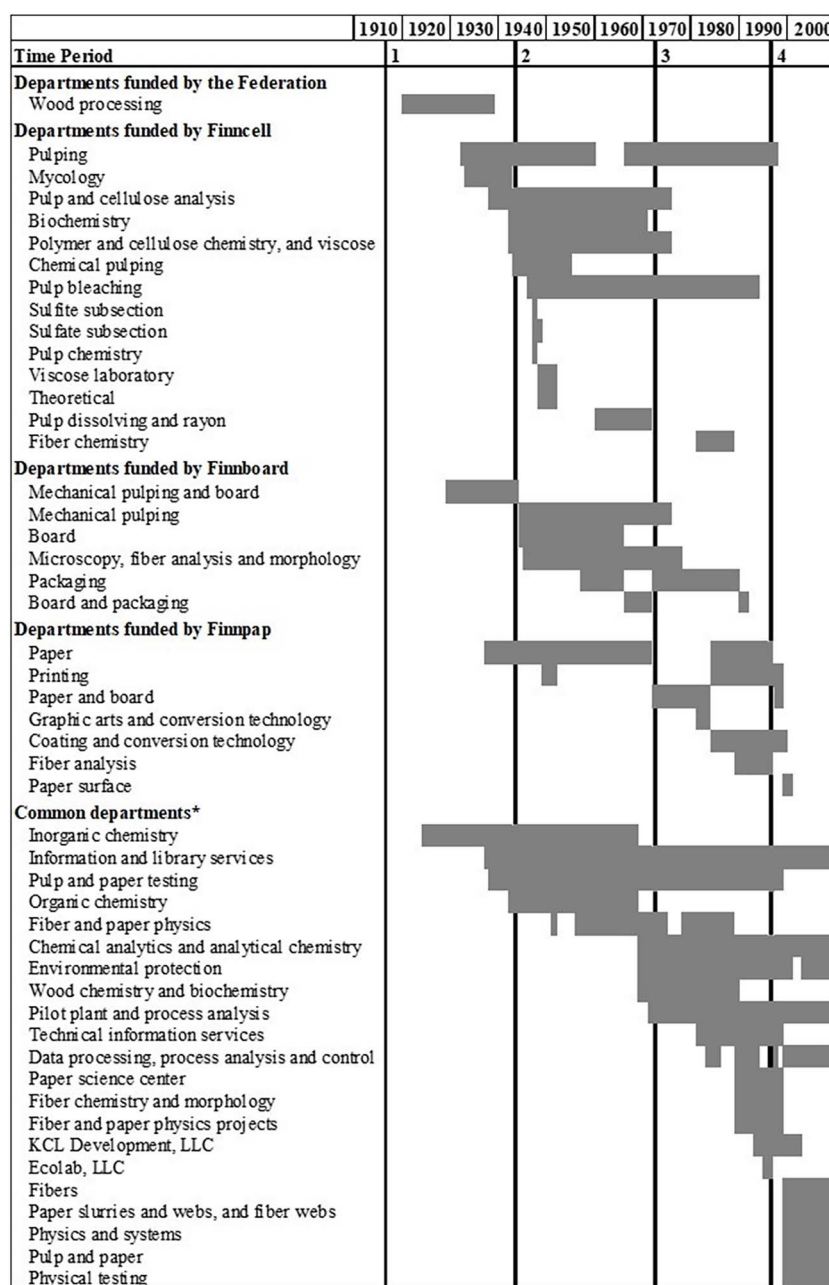
Table 4 Summary of KCL's scope of activities

Activity	Description	Source	Scale in the four time periods
1. Exploration	Development of new materials, products, and production processes	OD3; CD3; CD4; CD5; PD2, Grönvik (1966) ; Levlin (2010)	Critical (I, II, III) Relevant (IV)
2. Exploitation	Seeking marginal productivity improvements to existing processes through continuous improvement and problem-solving	OD3; CD3; CD4; CD5; Grönvik (1966) ; Levlin (2010)	Critical (I, II, III) Relevant (IV)
3. Technology transfer	Transfer of technologies, products, and processes—developed in (1) and (2)—from the laboratory setting to industry-scale production	OD3; CD3; CD4; CD5; CD6; PD1	Critical in all four time periods
4. Information services	Maintaining a centralized library and documentation services to alliance firms	OD3; CD6; Grönvik (1966) ; Levlin (2010)	Negligible (I, IV) Relevant (II, III)
5. International relations	Facilitating international cooperation; hosting international visitors; knowledge sharing; commissioned R&D work	OD3; CD3; CD4; CD6; SI2	Relevant (I, II) Critical (III) Negligible (IV)
6. Regulation	Creating technical standards both for internal use by alliance members (self-regulation) and for the industry more broadly (quasi-regulation)	OD3; CD6; PD1; Grönvik (1966) ; Levlin (2010)	Critical (I, II) Relevant (III) Negligible (IV)
7. Safeguarding transactions	Facilitating complex economic transactions by providing independent quality assurance and arbitration	OD3; SI1; SI2; SI3; Grönvik (1966) ; Levlin (2010)	Relevant (I, II) Critical (III) Negligible (IV)
8. Government commissions	Offering technical expert services (e.g. testing) to various government institutions in Finland	OD3; SI2; SI3; Grönvik (1966) ; Levlin (2010)	Negligible (I, IV) Critical (II) Relevant (III)
9. Education	Providing postgraduate internships, scholarships, dissertation thesis topics, and further education opportunities for technical experts	OD2; OD3; Grönvik (1966) ; Levlin (2010)	Relevant in all four time periods

took years before the state would be able to formulate and enforce any meaningful industrial policies ([Ojala et al., 2006](#)).

In the absence of state capacity for industrial policy, the role of a small industrial elite became critical; the elite included owners and executives of the largest firms, professors from the few existing universities, and a number of other individual experts. This turn of events is markedly different from the history of the Finnish shipbuilding industry that emerged in the 1950s in an environment characterized by a far more developed state agency and active industrial policy (see [Stutz and Matala, 2025](#)). Around 1920, the forest industry comprised over 80 pulp and paper firms, of which only about 20 had achieved sufficient scale for international competitiveness. The remainder were soon either acquired or ceased their operations ([Häggman, 2006](#); [Lamberg and Peltoniemi, 2020](#)).

The industrial elite was well informed about industrial policy practices in more advanced economies. As one of KCL's "founding fathers" wrote in 1919:



*Common departments include

- (a) departments dedicated to basic research
- (b) departments providing shared services and performing overhead functions
- (c) departments funded through revenue financing and/or run as stand-alone profit centers

Departments within each funding category are listed chronologically based on the year of founding

Figure 2 KCL's departments and their funding source

Thus begins a new phase in the development of Finnish industry. The country's natural products are being refined and exported. Technological progress is being applied resolutely, and efforts are being made to carry out this refinement as far as possible within our own country. Technological

progress is henceforth closely linked to developments in the civilized countries of Europe, and new machines are being imported into the country very soon after their first appearance. This continuous development is like a steadily flowing stream, ever stronger and more powerful. (Ramsay, 1919: 33)

Ramsay then continued by justifying KCL's founding:

The first attempt in this direction was also made in Finland when the Central Laboratory of Industry was established last year [...] there, the possibilities for the technical and economic utilization of our country's natural resources will be investigated. Only through our own work, even in matters of ideas, can a solid foundation for our own development be created.

Consequently, the founding of KCL was directly shaped by both international models and domestic constraints. Inspired by institutions such as the Mellon Institute and the Forest Products Laboratory in Wisconsin, as well as the Pulp and Paper Research Institute of Canada, KCL's founders envisioned a research facility that would bridge science and industry.

Professors Gustaf Komppa and Ossian Aschan played pivotal roles in this initiative. Aschan, trained in Germany,¹ understood that the success of the German chemical industry was rooted in scientific expertise, even though Germany lacked centralized research laboratories—each major firm operated its own. In the 1920s, as plans for KCL's first building progressed, Director Bergman and Professor Aschan undertook a comprehensive study tour, visiting 13 research institutions abroad. Their reports included architectural plans and operational insights, reflecting a commitment to learning from established models.

The founding team actively sought to identify the best international practices. In 1916, John Palmén, one of the founders, visited the Mellon Institute in Pittsburgh. His 1917 report meticulously documented the institute's structure, funding, facilities, and equipment, serving as a blueprint for KCL's development. A decade later, Director Bergman conducted another tour of North American research institutes, including MIT, Arthur D. Little Inc., and the Forest Products Laboratory. His 1929 report emphasized the vast resources, modern equipment, and strong industrial commitment to research—qualities that KCL aspired to emulate:

As a general impression from the visits to industrial research institutes in America, what remains are the vast—if not unlimited by our standards—resources regarding the institutes themselves, their maintenance and provision with the best and most modern equipment; a strong interest in the mission not only among the institutes' own staff but generally, and within industry a firm belief in research as the key to industrial and commercial success, even if it requires time and money to pursue.

Despite the ambition, the Finnish government was not only unwilling but also simply unable to support the initiative. Unwillingness originated in the broader political conflict between agriculture and industry, agriculture being more important at the time:

And as soon as the question arises of how the state should relate to different means of livelihood, opinions become sharply divided. For example, some are convinced that agriculture is best able to secure the livelihood of our people and must therefore be developed before all others; others believe that industry and trade offer the fastest and most certain path to prosperity for our national economy; there are also those who believe that merchants are downright parasites on society and that supporting large-scale industry is completely unnecessary. Instead of unanimity, there is complete discord. (Kovero, 1922)

Accordingly, during the critical phase of organizational development in the 1920s, industrial leaders stepped in, solidifying KCL's role as a private actor within Finland's institutional framework. These leaders also recognized that even the largest firms lacked international competitiveness and that

¹ Aschan had studied in the University of Göttingen, and worked in the laboratories of Bayer and Schering among other shorter visits and work experience in Germany.

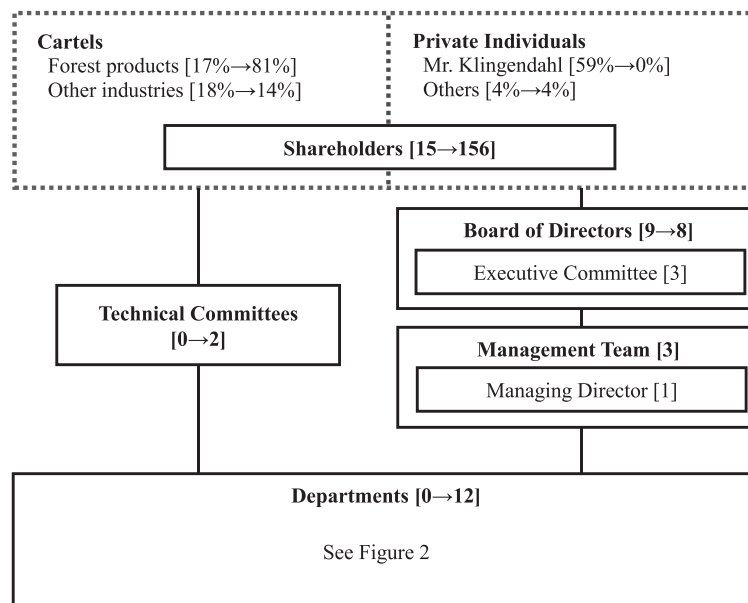


Figure 3 KCL's governance structure 1916–1943

the government would not resolve their challenges. The result was a distinctive form of *cooperative capitalism* (Schröter, 1997), in which firms created a *web of contracts* (Argyres and Liebeskind, 1999) that supported individual companies while simultaneously constraining them.

The web of contracts materialized in sales cartels. Pulp manufacturers joined the Finnish Cellulose Union (Finncell), paper manufacturers the Finnish Paper Mills' Association (Finnpap), and paperboard manufacturers the Finnish Board Mills' Association (Finnboard). These cartels coordinated international sales for their member firms (Koskinen, 1968; Laiho, 1998; Heikkinen, 2000), with most manufacturers belonging to all three. Sales cartels were legal forms of collaboration at the time (cf. Cortat, 2009). Rather than each Finnish pulp and paper manufacturer independently entering Western European markets, the cartels managed sales and executed transactions. They also had to ensure consistent product quality across manufacturers—a task that required a neutral third-party organization like KCL. Thus, the industry structure at KCL's founding is best described as centralized and integrated. Firms and cartels were closely linked through interlocking directorates. The need for centralization and integration stemmed from the founding vision: not only to build and organize the industry, but also to contribute to the industrial success of a newly independent nation-state. The absence of government funding meant that KCL assumed a role that, in many other countries (Amsden, 1997), was typically fulfilled by the state. As a result, forest industry development in Finland was shaped more by international market conditions than by domestic industrial policy.

5.1.2. Governance

KCL's organization had a distinct dual structure. One part was KCL's *corporate structure* (the right-hand side of Figure 3). The board had eight or nine members representing KCL's shareholders, specifically the cartel firms and private individual shareholders. Even though the bylaws [OD2] stipulated a 3-year term for board members, most members were re-elected to serve multiple terms, bringing stability to board composition.

KCL's resources were allocated through the corporate structure, aiming to obtain commissioned work from organizations outside the cartels. In the first two decades, the board of directors was central. It was not the managing director but the board—its three-person executive committee in particular—that formally represented KCL. Until 1936, the managing director was largely operational, primarily in charge of overseeing and managing the departments' daily activities. In this largely operational role,

the managing director made no strategic decisions, such as decisions regarding KCL's scale and scope. It was not until 1936 that KCL established a formal top management team consisting of the managing director and two vice directors [OD3].

The board made all the major decisions regarding scale and scope. It decided and allocated KCL's budget, commissioned the founding of departments, and recruited personnel [CD2]. However, the cartel side of the dual structure (the left-hand side of [Figure 3](#)) significantly influenced the scope of activities as the suggestions concerning scope came from the technical committees [CD4] that ensured the decisions served cartel interests. Most importantly, founding technical committees and nominating their members were the cartels' and cartel firms' prerogatives. Toward the end of the first period, the cartels developed a more significant role in KCL's financing, and consequently, technical committees gained prominence. Even though the managing director oversaw the departments, the technical committees exercised considerable oversight over research activities. A case in point, the first department—Wood Processing, founded in 1920—was organizationally separated from KCL as an independent accounting unit, whose cash flows were separated from the rest of KCL [OD3; CD2]. This independence was deemed desirable because the department's activities were directly financed and at least indirectly managed by the forest product cartels.

The main reason for the growing influence of the cartels was that the sources of KCL's funding changed drastically in 1943. By the end of the first period, about 70% of KCL's funding was budget financing [OD3]. By 1943, the two forest products cartels (Finncell and Finnmap) and their members owned over 80% of KCL's shares. As the primary financiers of KCL, cartel firms wanted to maintain decision-making and oversight roles. In addition to notable changes in the financing structure, KCL also saw a drastic increase in the scale of its activities. The absolute financing volume at the end of the period is about 20 times that at the beginning of the period. This corresponds to an average annual growth rate of 12%. Due to the increasing volumes and the increasing proportion of budget financing, alliance members were asked to contribute to KCL's activities in drastically increasing amounts.

5.1.3. Scope

KCL's original aim was to develop testing methods and standards for the pulp and paper industry, experiment with new production processes, and improve the efficiency of existing processes [OD3; CD5; [Grönvik, 1966](#)]. The early activities included tailored projects financed by cartels or individual firms. Cartels were interested in industry-wide quality assurance and general problem-solving, whereas individual firms sought KCL's expertise in developing solutions to firm-specific problems. Around half of KCL's work was commissioned by firms outside the pulp and paper industry.

In 1920, the Central Association of Finnish Woodworking Industries donated to KCL to establish a research department dedicated to wood-processing research, focused on testing, standardization, and quality assurance [CD2]. In addition to pulping and papermaking processes, KCL continued to work with other industries, and as a result a department of inorganic chemistry was founded in 1924. However, the focus shifted increasingly to pulp and paper resulting in the founding of the mechanical pulping and board (1929), the chemical pulping experiments (1932), and the paper (1937) departments.

KCL's projects led to the formation of technical committees that were in charge of allocating the donated funds [CD3]. In 1920, KCL established the Process Monitoring Methods Committee to develop standardized metrics for chemical pulp properties ([Grönvik, 1966](#): 29). The problem at the time was that the absence of standardized metrics hindered international trade. The standards KCL developed were ultimately embedded in various technical procedures and physical measurement equipment, which also garnered significant international interest. It was both in KCL's and in the cartels' best interests to seek the international diffusion of KCL-developed standards.

In addition to standardization, KCL started to develop its role in safeguarding transactions, typically in quality assurance. In 1925, Finncell requested that KCL perform monthly inspections of pulp quality at every pulp mill to ensure that all the cartel members were kept up-to-date on the pulp quality produced by all the cartel plants [CD4]. This was crucial because the pulp produced in the cartel plants was sold using standard prices through the same sales organization. In 1930, the cartel implemented a Quality Compensation System by which the cartel would award a price premium to higher-quality pulp producers ([Grönvik, 1966](#): 60).

In addition, internal audits functioned as pre-emptive measures safeguarding transactions. Knowing that KCL would not only assess quality but also publish the results of its assessments across cartel firms gave plant managers a strong *ex ante* incentive to focus on quality. To complement this, KCL also acquired a central *ex post* role by acting as a third-party arbiter in contractual disputes over quality, both among cartel firms and between cartel firms and their external customers ([OD3]; Grönvik, 1966). KCL's response to market failures was therefore a matter of both self-regulation of its members as well as quasi-regulation of the industry more broadly. Regarding the latter, since regulation was a matter of private ordering (not public oversight), the essence of regulation was "authority *in* markets (rather than over markets)" (Sinclair 2001: 442)—hence the term *quasi-regulation*.

In addition to the two forms of regulation, KCL had a role in the execution of specific transactions. For example, to prevent contractual failure, the contract between a buyer and a seller might stipulate that KCL function as an independent and disinterested "private judge" (Milgrom *et al.*, 1990) to ascertain the quality of the seller's product. Despite having cartel firms as its shareholders, KCL built a reputation of a competent and impartial arbiter of disputes.

Finally, KCL's shareholders and executives realized early on that effective R&D would require systematic information management. In 1937, KCL established the Library and Information Services Department [CD2; CD6] that would serve as a repository of state-of-the-art scientific knowledge. In its service role, the department would periodically conduct systematic literature reviews of recent research findings.

The first period ended during the Second World War, which profoundly impacted KCL's scope, particularly in terms of its exploration activities aimed at developing new products. KCL was directed by the state to develop various substitute materials, such as dissolving pulp to substitute cotton fibers in textiles, and a method to use tar to produce industrial lubricants (Grönvik, 1966: 77; Mäki, 2009). The Second World War was a significant catalyst to KCL's exploration but not its primary driver. As KCL's founding fathers were raising equity in 1916, they envisioned and advertised the prospective organization as a laboratory focusing on exploration with new materials, new product development, and process improvement. The Second World War provided a fortuitous opportunity to put these skills to use.

5.2. Period II (1943–1972): from laboratory-scale to industrial-scale research

5.2.1. Historical context

The "new" KCL emerged during and after the Second World War into a markedly different social environment than in 1916. From 1943 onward, KCL focused exclusively on the forest industry, assumed new responsibilities, and held an undisputed position within the forest industry innovation system—still grounded in the principles of cooperative capitalism. The strengthening of KCL's role was directly linked to the societal dynamics shaped by the war and its aftermath.

First, the Second World War constituted a broad collective effort across Finnish society, particularly involving firms, the industrial elite, and KCL. Both companies and KCL played a fundamental role in the war economy by producing and innovating goods essential for the functioning of the military and civilian infrastructure (Aunesluoma, 2007). These contributions ranged from paperboard-based tents and mobile housing to caskets and substitute products (Grönvik, 1966). Moreover, individuals affiliated with KCL and the forest industry joined the military as officers and experts, or assumed governmental roles as ministers, ambassadors, and representatives in negotiations with Germany and Sweden—the only remaining buyers of Finnish exports in the period 1941–1944. As the excerpt below illustrates, wartime conditions reduced tensions between different sectors of the economy, elevated KCL's societal value as a leading institution for technological advancement in the forest industry, and reinforced a sense of collectivity among the industrial elite:

I think Kotilainen was the key figure who brought these elements together and argued that it would be a mistake for everyone to design their own factory, as each would end up being too small. (From the 1982 interview of Pentti Halle, former CEO of Enso-Gutzeit)

Second, in the postwar period, Finland began paying war reparations to the Soviet Union. Although these reparations primarily involved metal industry products, forest industry firms played a crucial role as the largest source of foreign trade income (Oksanen and Pihkala, 1975). The prevailing spirit remained highly collective, with government officials urging patience and sacrifice in the national reconstruction effort. The prime minister's (Kekkonen, 1952) question "Does our country have the discipline to prosper" directly referred to a new era in industrial policy in which the Finnish state would take a dominant role.

Many forest industry firms had lost production equipment and entire factories to the Soviet Union, further deepening the sense of solidarity among industry leaders. These conditions left little room for alternatives to cooperative capitalism, with KCL continuing as a central institution within this framework:

It [forest industry] now has unquestioned control over the company [KCL]. When dividing the shares the forest industry firms at the same time made the commitment to finance the laboratory's activity with sufficient funds. Therefore, we believe that the laboratory's future development will be favourable, and we can expect even more successful activity to benefit our industry. For this it also has good preconditions due to expansions and reorganizations completed recently. (Brax 1944 in a speech to engineers representing different member firms [PD3])

Third, the nature of industrial policy underwent a transformation during and after the war. The previously passive "night-watchman" state evolved into a more proactive agent in industrial development. Central to this shift was the role of the Commission for the War Reparations Industry (SOTEVA) (Rautkallio, 2014), and VTT Technical Research Centre of Finland, founded in 1942. The role of these centrally managed entities, whose leadership was drawn from the largest industrial firms, was to coordinate the specific reparation demands of the Soviet Union. A significant byproduct of this process was the Finnish government's first significant engagement in industrial policy, which led to the emergence of interventionist strategies, including the establishment of state-owned enterprises, new technical universities, and R&D institutions to support industrial growth (Michelsen, 1993). VTT, for example, reached a central position in the standardization of the war reparation products, and later became a direct competitor of KCL.

KCL, however, remained an independent institution, governed by private ordering and financed by forest industry firms. Archival materials from the 1940s and 1950s reveal no challenges to the role of KCL, which continued to function as a collective effort within the forest industry ecosystem. In fact, KCL assumed new responsibilities at the intersection of industry and the broader institutional and regulatory framework.

5.2.2. Governance

By 1943, KCL had developed into an R&D alliance of the forest industry cartels who had bought out all the other shareholders (see Figure 4). Furthermore, KCL's board was populated entirely by cartel members, and the shareholders' meetings were attended primarily by board members representing a controlling blockholder [CD1].

At the same time, KCL faced a fundamental governance challenge. Member firms were constantly asked to increase their financial contributions to finance specialized R&D activities and specialized assets such as the pilot plant; financing specific assets is always contractually hazardous (Williamson, 1985). However, without continuing and increasing budget financing, KCL would not survive. As a result, in the early 1970s, budget financing constituted the vast majority of KCL's funding. There were concerns that this would not be tenable, mainly since KCL's scale of operations was growing at an increasing rate.

The role of the cartel structure was further strengthened as the number of technical committees increased to 24 by 1966 [OD3; CD4]. This meant that there were hundreds of industry representatives seeking to guide KCL's future research focus, yet they also gained information on KCL research results through biannual committee meetings. The technical committees were *de facto* in charge of KCL's scope. At the same time, and not surprisingly, cartels became the most important source of KCL's financing, accounting for almost 80% of KCL's spending by the end of the 1960s; commissioned work declined to less than 20%. In sum, KCL had essentially become an "R&D extension" of the pulp and paper cartels in

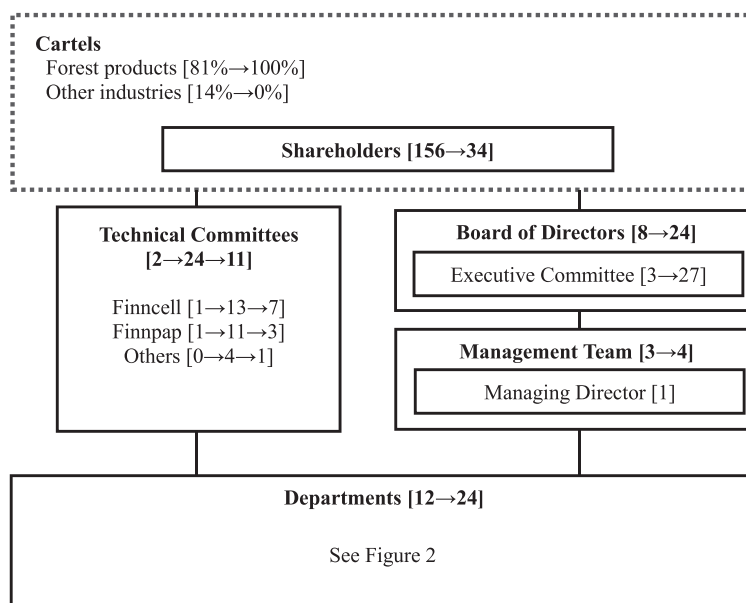


Figure 4 KCL's governance structure 1943–1972

that the cartel firms would conduct some firm-specific R&D within their respective organizations but, at the same time, commissioned other projects to KCL. KCL was effectively used to reap in economies of scope: cartel firms would channel to KCL those R&D projects where the firms shared a common interest.

In the late 1940s, KCL began to collaborate with universities in providing opportunities for thesis projects and granting scholarships. Moreover, some basic research tasks were subcontracted to university professors. Technical committees also made the initiative of sending systematic reviews and test method reports, so far reserved for funding firms only, to teachers and lecturers.

5.2.3. Scope

The major trend in KCL's scope was the increasing output diversity. Primarily due to the war, KCL pursued the exploration of substitute materials [OD3]. The work commissioned by the Finnish government led to new research areas, such as viscose and biochemistry. In the 1940s, eight new departments were founded.

In addition to being a catalyst for the exploration of new products, Finland's coping with the repercussions of the war also bolstered KCL's role in creating industry standards. A case in point, the War Reparations Committee tasked KCL to develop conversion tables by which the Soviet metrics used to characterize pulp and paper could be translated into metrics used in Finland (Grönvik, 1966: 80). This would facilitate Finland's mandatory war reparations to the Soviet Union, as stipulated by the Moscow Armistice of 1944. The war reparations were to be paid in the form of industrial goods, including wood and paper.

In constructing the conversion tables for the Soviet exports, KCL acquired further expertise in standardization [SI2], which was becoming increasingly important due to the expansion of international trade (Levlin, 2010: 112–113). When the International Organization for Standardization (ISO) established its subcommittee on chemical pulping testing methods in 1958, KCL's managing director, Professor Waldemar Jensen, was appointed as the committee's chairperson and the committee secretariat was assigned to KCL. In conjunction with standards, by 1966, KCL had developed 170 testing and analysis methods, therefore consolidating its role as an expert authority in international standardization [PD1].

Rebuilding societies in postwar Europe was a time of rapid growth, which led to an explosion of demand for pulp and paper products. The urgency to expand capacity and improve productivity encouraged product development, which required gaining a deeper understanding of the chemical properties

of raw materials. In 1947 KCL's board of directors decided to shift KCL's focus more to basic research on pulping chemistry [OD3; CD2]. In the 1950s, KCL experimented with novel materials such as eucalyptus, grass, and straw in pulp processing. In 1956, KCL started to explore ways to reduce industrial waste. Experimentation with material structures paved the way toward innovations in by-product development (Magnusson, 1996: 37).

KCL also broadened its activities from laboratory scale to "semitechnical scale." Whereas laboratory-scale research helped in understanding the underpinning chemistry, semitechnical research was necessary to uncover how new materials (e.g. fibers, pigments, and additives) performed under conditions that resembled actual production processes as closely as possible [SI1; SI2]. Such production trials were essential to uncover the viscoelastic properties of materials under conditions that simulated the temperatures and high processing speeds of authentic production situations. In 1955, KCL's board established a subcommittee to explore the building of a pilot plant, the designated site for semitechnical research [CD2]. By the end of period II, the pilot plant contained production equipment that allowed the simulation of the entire production process of high-value-added paper grades. In 1971, the pilot plant was incorporated into KCL's formal structure as a department [OD3].

Finally, period II introduced various environmental concerns, most notably water pollution. When the Wastewater Act of 1961 was enacted, KCL was involved as an external expert both in drafting the law and in the design and implementation of various surveying methods (Grönvik, 1966: 113; Levlin, 2010: 93–94). Through this role and several other similar ones, KCL started to bolster its reputation as a neutral expert not only within the industry but also more broadly in Finland. Within the industry, KCL's role was often explicated and formalized in buyer–supplier contracts. For example, when an original equipment manufacturer built a pulp-processing mill for a KCL member firm, the contract stipulated that KCL would perform quality inspections during production ramp-up to ensure that production output conformed to specifications [OD3; SI2]. This created an *ex post* safeguard for the relation-specific transaction that involved a sizable sunk cost on the buyer side.

5.3. Period III (1972–1996): from industry-level to corporate-level strategies

5.3.1. Historical context

Period III, along with the immediate dynamics preceding it, marked a transition from cooperative capitalism to a more firm-centric, competition-based environment. This shift reflected broader societal changes on the one hand, and, on the other, the strategic and structural choices made by firms.

The first major development concerned the role of the Finnish state in the 1960s and 1970s, which differed markedly from earlier decades. The economic structure had shifted from agrarian to industrial: Agriculture's share of GDP had declined from 25% in 1945 to 10% by 1970, giving way to industrial production and services (Hjerpe, 1989). Simultaneously, the Finnish government adopted a more active and interventionist stance in industrial policy, encompassing state-owned enterprises, trade relations, and, crucially, the knowledge base required for competitive industries. In the postwar period, six new universities were established, four of which included faculties in engineering and applied sciences, with dedicated research units in paper engineering and chemistry (Michelsen, 1999). Also, VTT's rapid growth in the 1960s and the 1970s provided forest industry firms with alternative sources for R&D and testing (Michelsen, 1993).

Another significant disruption was the gradual delegitimization of cartels. Following Finland's trade agreement with the European Economic Community (EEC) in 1973, it became evident that cross-firm coordination of prices and sales would be prohibited at some point (Kuisma, 2008). Further, the Finnish Competition Act of 1988 granted the Finnish Competition Authority "the right to abolish agreements that were deemed harmful, and the definition of what constitutes a harmful cartel was widened" (Hyytinen *et al.*, 2018: 193). While sales coordination through cartels had been effective in earlier years, firms increasingly recognized that cartel membership constrained strategic autonomy. Rising product differentiation made companies more idiosyncratic, as they focused on firm-specific issues, thereby reducing economies of scope in joint R&D.

Ultimately, as cartels started to disintegrate, industry-level strategies rooted in industry-level considerations and cooperative capitalism gave way to corporate-level strategies. Despite the gradual disappearance of cartels, pulp and paper companies continued to own and manage KCL. Industry-wide mergers and acquisitions reduced the number of firms from 31 to 9, and forest industry firms evolved from a collective orientation toward independent multinational enterprises. Initial attempts at internationalizing production occurred in the 1950s and 1960s, first through ad hoc alliances and later independently when alliances proved problematic. Larger-scale and international operations necessitated the development of strategic capabilities (Chandler and Hikino, 1997), often supported by consulting firms such as McKinsey. By the early 1970s, the largest firms had emerged as publicly owned industrial corporations with M-form structures and a growing confidence in their ability to address complex challenges without reliance on domestic competitors. Increased size enabled the establishment of in-house R&D laboratories, while sharper strategic focus encouraged secrecy in product development rather than sharing with competitors—as recalled by an executive from a major company describing how, in the mid-1960s, the firm developed new technology for liquid packaging board independently of KCL.

We wouldn't have got anywhere if we hadn't believed in the future of milk packaging and boldly set out to develop the business and strengthen our own ability to solve the challenges we faced along the way. (SIAR report, 1977)

5.3.2. Governance

KCL experienced its most profound organizational changes in the early 1970s. KCL's history aptly illustrates the organization-economic maxim (e.g. Williamson, 1985) that *ex post* adjustments are more central than the *ex ante* contract in long-term relationships. The insight originates in Ronald Coase's seminal work on the nature of the firm and the concept of *incomplete contracting*: "[T]he longer the period of the contract is for the supply of the commodity or service, the less possible, and indeed, the less desirable it is for the person purchasing [here, KCL] to specify what the other contracting party [here, the member firms] is expected to do" (Coase, 1937: 391). KCL effectively illustrates how relying on an *ex ante* contract is not efficient when contracts are incomplete.

Adjustments in the general governance of KCL were frequent in period III. Most importantly, this involved KCL's board dynamics, both in board membership and in the scope of the board's activities. Here, the tradeoff is like the tradeoff in membership dynamics: a member firm getting to appoint a board member and thus be granted an oversight role boosts the organization's credibility in the eyes of the member. But the tradeoff is that broad participation on the board may adversely affect the board's ability to function efficiently as interests become diluted (Williamson, 2008). In the late 1960s, decisions regarding KCL's scope were made in an increasingly complex governance structure. With two dozen technical committees, several hundred individuals were involved in scope decisions, which became untenable [CD2]. At the same time, as critical letters [CD8] from two shareholders to KCL's board demonstrated, some members felt excluded from KCL's governance. Paradoxically, there seemed to be simultaneously too many and too few decision-makers involved in strategic decisions. New ideas for expanding the scope were abundant. Still, at the same time, KCL lacked the organizational mechanisms to offset expansion by eliminating departments or individual projects that had run their course.

KCL's corporate structure (Figure 5) was elaborated in the renewed governance structure implemented in the third period. Each member firm could appoint a member to the board of directors, which expanded the size of the board to a total of 24 members. Similarly, each member firm could appoint a member to the Executive Committee. The expanded Executive Committee was to consist of individuals with a broad-based industrial understanding [OD2].

The Executive Committee included the Research Committee, which consisted of one member of the Executive Committee as chairperson and seven industry representatives as members. As a general rule, the industry representatives were technical experts employed by the cartel firms. The Research Committee advised the Executive Committee as it prepared KCL's research and budget proposals—effectively proposals of KCL's scope—to the board. Their expertise was instrumental in KCL's scope

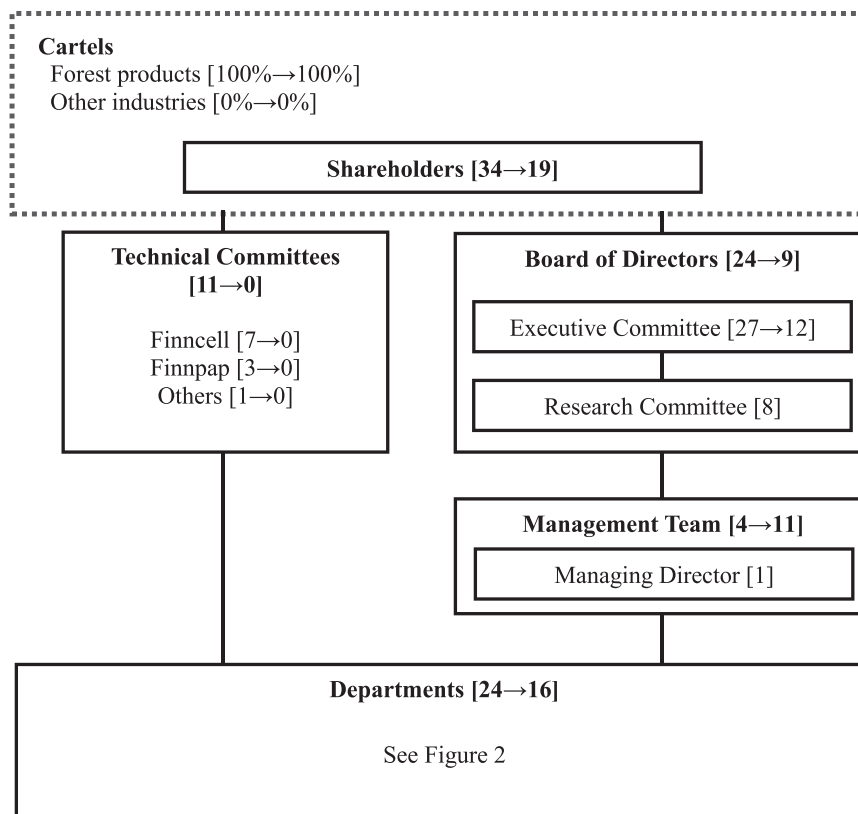


Figure 5 KCL's governance structure 1972–1996

decisions. Most importantly, the Research Committee was responsible for creating the formal processes by which alliance members could propose projects for KCL to fund.

Incidentally, the increasing complexity of KCL's organization and governance was offset by industry consolidation. Primarily through acquisitions, the number of KCL's shareholders declined from 34 in 1972 to 19 in 1996. This consolidation meant that by the end of period III, it was feasible to offer all the firms participating in budget financing a seat on the board of directors.

5.3.3. Scope

The three central drivers of KCL's scope in the third period were (i) calls to focus and prioritize, (ii) growing environmental concerns, and (iii) the shift from industry- to corporate-level strategies. By the 1970s, KCL's member firms had become aware that the key to future competitiveness lay in effective corporate strategy. Many started questioning how their firms benefitted from KCL membership. Smaller members questioned the dominating role of large members on KCL's board. This tension led to the 1967 "Myllykoski Brief" [CD8]. Myllykoski, one of KCL's comparatively smaller shareholders that had never held a board seat, was unhappy with what seemed to be the ever-expanding scope and volume of KCL's activities. In the 1976 "Kymi Brief," a more prominent shareholder insisted that KCL rein in its increasing costs and increase the proportion of revenue financing [CD8]. Budget financing accounted for nearly 80% of KCL's funding, which was deemed untenable.

The main initiative for focusing and prioritizing KCL's activities was the formation of the Planning Committee of 1968. In its report, the Planning Committee proposed 11 key areas, including general research issues such as the improvement of paper and cardboard coating processes, reduction of waste by maximal use of raw materials, and economies of scope in production. All these initiatives would call

for a better understanding of the fundamentals of the materials and processes, with less focus on specific products.

Increasing awareness of environmental issues had significant implications for KCL's scope. For example, KCL participated in the legislative drafting of the Wastewater Act. The Finnish Government established also the Water Protection Committee that delegated the regulatory oversight of the bodies of water affected by pulp and paper production to KCL (Grönvik, 1966: 113; Levlin, 2010: 93–94). KCL continued in this oversight role until the 1990s. Deciding whether private actors should be involved in policy-making can benefit from a comparative efficiency analysis (e.g. Williamson, 1999). Using private expertise in policy formation is analogous to arbitration in the sense that the private actor is more likely to have a nuanced, contextual understanding of the policy issue at hand. In contrast, public actors are more likely to produce policies that are less sensitive to context, that is “more codified, institutionalized and juridified” (King and Sinclair, 2003: 349). The inefficiency concern of private actor involvement arises from the familiar agency problem: will the private actor's behavior align with the public interest? There is certainly no natural inclination for that—just the opposite.

KCL also continued its function as a private judge. One part of this was settling disputes among its members over quality-related complaints. As pulp and paper companies expanded their production by opening new production sites in the 1970s and 1980s, the demand for KCL's expertise in safeguarding transactions increased as well. KCL's task was to ensure that the functioning and the output of a production process investment supplied to one of the alliance members by external suppliers met the conditions specified in the contract [SI2]. Just like in the case of delegated regulatory oversight, the contracting parties found KCL to be an impartial judge.

The shift from industry-level to corporate-level strategies prompted KCL's shareholders to conduct more rigorous cost–benefit analyses at the firm level. Since strategy was becoming primarily a corporate-level concern, what purpose would an industry-wide R&D alliance serve? Firms had become sufficiently large to enable considerable internal R&D investments and were no longer dependent on KCL or the cartels. The most prominent indication of KCL's declining relevance was the resignation of Nokia, whose corporate scope was changing in ways that eroded KCL's relevance (Nokia's resignation letter, November 27, 1984). Many alliance members similarly increased their internal R&D spending, similarly rendering KCL's activities less relevant.

5.4. Period IV (1996–2009): toward industry consolidation

5.4.1. Historical context

Finland joined the EU in 1995 and became an integral part of Western Europe, both economically and politically. Roughly 70% of pulp and paper exports from Finland went to the European market. At the same time, large corporations had built production units worldwide, and competition had become decidedly global. In 1996, only four member firms remained: UPM, Stora Enso, Metsäliitto, and Myllykoski. Aside from Ahlström's resignation in 1994, the decline in membership was mainly due to industry consolidation. This meant that the funding base of KCL would remain unaffected, because payments were based on sales volume. However, a new funding agreement was signed in 1988 that also took into account the sales of mills located abroad, as well as those of partially owned subsidiaries. In February 2009, the KCL board decided to sell KCL research operations to VTT, leaving only the pilot plant for KCL to operate (Levlin, 2010).

5.4.2. Governance

KCL's governance structure started to resemble that of a conventional limited liability corporation (Figure 6). Scope decisions were made within a conventional corporate structure. Only four corporations—three large and one comparatively smaller—participated in funding KCL. The three larger firms appointed two board members and the smaller firm one member [CD1; CD2]. The Executive Committee was eliminated in 1996.

Since board members were industry and business experts, they still had technical expertise to guide KCL's scope decisions. To this end, the role of the Research Committee remained crucial. The Research Committee composition mirrored board composition in that the three prominent members could nominate two experts each and the minor member one expert. However, research and production

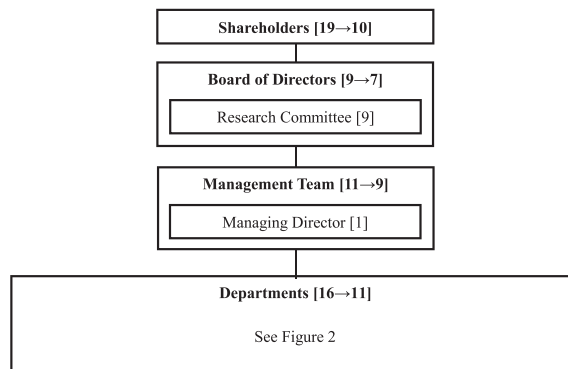


Figure 6 KCL's governance structure 1996–2009

expertise was the primary selection criterion for inclusion, and Research Committee members, for the most part, did not simultaneously serve on KCL's board of directors [CD3; CD2]. Another manifestation that KCL was becoming more corporate-like as an organization was the increasing reliance on revenue financing. By the turn of the millennium, revenue financing exceeded budget financing.

For all practical purposes, the fourth period marked KCL's end as an R&D alliance. As firms continued focusing on firm-level strategies, they accumulated the requisite internal expertise by investing in all the relevant business functions, including R&D. In fact, membership in KCL was at times construed as a potential liability: One informant noted that firms deliberately avoided joint R&D initiatives out of fear that public authorities would bring forth cartel accusations [SI1].

Divestment of the R&D activities did not mean the end of KCL. While KCL divested exploration, its exploitation and industry service activities are still operational today. The KCL pilot plant continues to offer a pilot-scale testing and production platform for its customers to develop their products and processes. In 2022, the KCL pilot plant was sold to its management and external investors.

5.4.3. Scope

The expansion of firm-level R&D activities made KCL's role increasingly redundant. As a result, KCL's scope narrowed drastically during the fourth period. The distinction between exploration and exploitation became more pronounced [SI3]. Specifically, exploration drifted more toward basic research as the Paper Science Center was established and participation in EU-level research projects increased. Regarding exploitation, the emphasis shifted more toward consulting, quality assurance, and client-specific projects at the pilot plant. A third expansion to KCL's pilot plant supported exploitation and knowledge transfer. Finally, KCL's role in organizing international relationships withered, as firms ran all aspects of their international operations in their internal functions and interest in Nordic collaboration decreased (Levlin, 2010: 105).

5.5. Epilogue: theoretical insight on the Organization of R&D collaboration

Before moving on to a discussion on the theoretical implications of our analysis for catch-up through the emergence of a sectoral system of innovation, we find it useful to examine, as a precursor, a few proximate theoretical implications that link to the *ex ante* alignment and the *ex post* adjustments in the KCL case. We do this by examining the exogenous and the endogenous factors that both the industry in general and KCL in particular faced over the four time periods (cf. [Malerba and Lee, 2021](#): 987). These factors and the corresponding governance responses are summarized in [Figure 7](#).

[Figure 7](#) establishes that while KCL started as an R&D laboratory, it evolved into something much broader, specifically, an architect of industry-level collaboration through industry self-regulation, quasi-regulation, and dispute resolution. KCL had an instrumental role in eliminating free-riding problems and contractual disputes through the authoring of standards and mediating disputes as a private

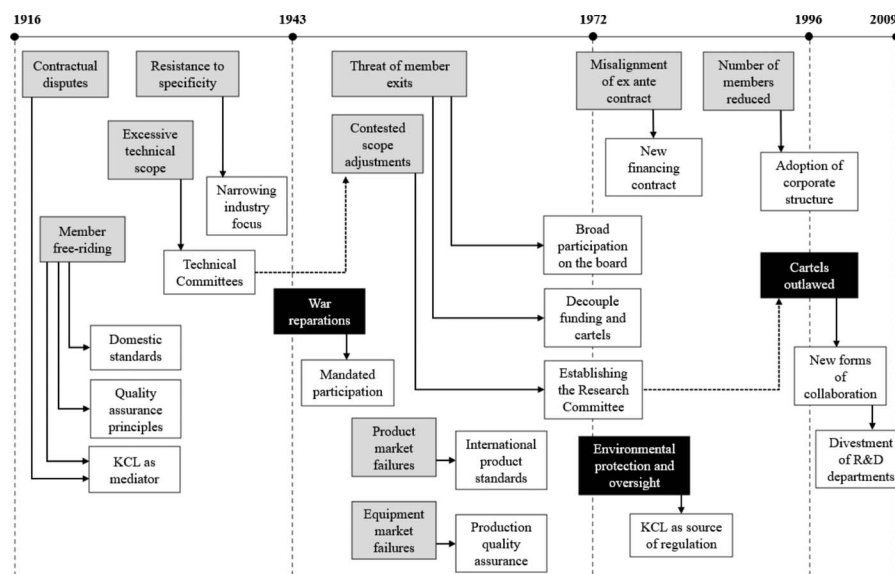


Figure 7 KCL's endogenous (gray) and exogenous (black) challenges and governance responses (white)

judge, effectively providing *ex post* safeguards for transactions. To complement this, KCL's quality assurance processes and international standards addressed broader market failures by providing the corresponding safeguards on the *ex ante* side. Therefore, KCL was an indispensable catalyst in creating mutually credible commitments, which was achieved exclusively through the mechanisms of private ordering. We say *indispensable*, because we find it unlikely that third-party ordering (i.e. courts) could have efficiently adjudicated disputes that clearly called more for substantive (technological) than legal expertise (see also Williamson, 1983: 521).

Viewed through the lens of Figure 1 and the different orders of economizing, KCL's role was to promote the efficient allocation of resources and incentive alignment ("third-order economizing") within the industry by ensuring that the relationships are governed efficiently ("second-order economizing"). Toward this end, an equity joint venture (as opposed to collaborative contracting) offered a comparatively efficient alternative, primarily due to its ability to facilitate *ex post* adjustments (see also Williamson, 1996: chapter 6).

While KCL's role in ensuring the effective allocation of resources and incentive alignment was instrumental to technological development, its role as an architect of within-industry collaboration is only part of the story. Even more fundamentally, KCL became an architect of not only collaboration but also the institutional environment. Understanding how KCL ultimately became an *institutional architect* is key to understanding how catch-up in the Finnish pulp and paper industry occurred and how the corresponding *sectoral system of innovation* (Malerba, 2002) developed. Importantly, KCL's role as an institutional architect coevolved with the state's capacities in industrial policy, evolving from a "night watchman" to a resourceful facilitator of industrial change. This ultimately led to the decline of KCL's role, which had been central at the outset. Consequently, the state would finally be able to assume the kind of role that Gerschenkron (1962) had envisioned.

6. Discussion

The challenge in developing an entire system of innovation in a technologically intensive sector such as pulp and paper is two-fold. One challenge lies in how the technological competencies of individual firms are harnessed for industry-wide collaboration—we call this the *technical capability* dimension. The other challenge is how to establish, maintain, and adjust the broader institutional environment in which the technologically competent firms collaborate (cf. Malerba, 2002: 250–251)—we use the term *institutional*

capability in reference to this second dimension. Institutional capability corresponds to Abramovitz's (1986) term *social capability*, but since the capability relates specifically to the development and maintenance of the relevant institutions (as Abramovitz himself argued), we propose institutional capability as a descriptively more precise label.

Earlier theorizing in institutional economics (e.g. North, 1991; Acemoglu and Robinson, 2012) and research on industrial catch-up (e.g. Lee and Malerba, 2017; Malerba and Lee, 2021) have emphasized the importance of efficient institutions and a resourceful state (Amsden, 1992) as a boundary condition for the accumulation of technological know-how and subsequent economic growth. Projecting from the seminal works on sectoral systems (e.g. Nelson, 1993; Malerba and Nelson, 2011), a predictable and manageable institutional environment emerges as a necessary condition for the development of sectoral systems of innovation. But the unexplored question is "Who is the architect of the institutional environment?" To be sure, institutional capabilities, just like technical capabilities, must be deliberately developed. As Abramovitz (1986: 388) noted, "countries learn to modify their institutional arrangements and then to improve them as they gain experience." But what do we mean when we say that "countries modify" or "countries improve"? A country is perhaps best construed not as an actor (who catches up) but a context (in which catch-up occurs) (Lundan and Cantwell, 2020). As Malerba and Lee (2021: 987) pointed out, the evolutionary process of catch-up "unfolds to a considerable extent at the sectoral level." Our analysis strongly echoes this point.

In the context of a technology-intensive industry, technical capability is a matter of substantive expertise that resides largely in the private corporations who engage in manufacturing and development activities. In the case of the evolution of the Finnish pulp and paper industry, a joint-equity R&D alliance became the central vehicle in both organizing and further developing the requisite substantive expertise (through joint R&D) and enabling the efficient governance of within-industry relationships (through self-regulation, quasi-regulation, and dispute resolution). However, our analysis suggests that the same substantive experts may also contribute to the institutional capability. Therefore, the technical and institutional capabilities both have private ordering at their foundation, which echoes the central messages from organizational economics (Williamson, 1983).

The role of substantive expertise in the morphing of the institutional environment becomes salient as we recognize that many of the issues related to formal regulation and legislation in industries such as pulp and paper are matters of substantive expertise. As an example, let us briefly compare what kinds of expertise were required in authoring the Limited Liability Companies Act of 2006 versus the Wastewater Act of 1961. While the former focuses on the general requirements imposed on the corporate form, the latter delves deep into issues of substance. A case in point, one of the issues the Wastewater Act covers in extensive detail is the transporting of felled tree trunks along bodies of water through a process known as "timber rafting." How could efficient legislation possibly be created, ratified, and enforced without detailed, substantive experience? For the purposes of our argument, the central difference between the Limited Liability Companies Act and the Wastewater Act is that the latter contains significant *sectoral content* while the former contains none. The Wastewater Act of 1961 (in the drafting of which KCL had a central role) is but one example of the symbiotic relationship between sectoral innovation systems and the institutional environment within which catch-up occurs. In such institutional environments, the role of private actors and the processes of private ordering are central in the development of both the technical and institutional capability.

The participation of private actors in legislative and policy-making processes is, of course, not novel (King and Sinclair, 2003). In a latecomer country, only private actors are likely to possess the requisite technical expertise. However, the challenge lies in the fundamental tension between private and public interests that are, at best, only partially overlapping and, at worst, in direct conflict. Delegating the drafting of the Wastewater Act to just *one* private corporation would likely have been ill advised due to obvious "vested interests, established positions, and customary relationships" (Abramovitz, 1986: 389) that any individual corporation might have had. This is where the notion of efficient governance as a mediating mechanism becomes relevant: as an industry-wide nonprofit alliance where no vested interest or established position wielded excessive power, KCL functioned as a governance mechanism to curb strongly self-interested behaviors. As the events in period III indicated, those with a strong self-interest simply exited the alliance instead of trying to steer its focus toward an idiosyncratic corporate

interest. We propose that this is precisely why KCL gained and maintained legitimacy in the eyes of public actors. We further surmise that in structuring KCL as a nonprofit industry-wide alliance at the outset, KCL's founders were exercising foresight and already anticipated a potentially broader institutional role. Similarly relevant is the fact that KCL was established specifically as a separate legal entity (an LLC) to which the drafting of a policy initiative or a law could be delegated in the first place. Had the collaboration been structured through a series of collaborative contracts, no such entity would have existed. KCL's articles of incorporation certainly give us plenty of reasons to infer significant *ex ante* foresight.

7. Conclusion

Private corporations have an indispensable role in the development of sectoral systems of innovation and industrial catch-up. In this article, we have shown that this role can extend beyond contributing to the development of technical capability to institutional capability, or what Abramovitz (1986) called "social capability." Specifically, in the context of sectoral innovation systems, the development of the institutional environment links significantly to issues of substance, making the technical and the institutional capabilities symbiotic. Because technical capabilities are scarce and often reside within individual private corporations, the development of institutional capabilities unavoidably involves private actors. At the same time, private and public interests are sometimes in direct conflict. How is this conflict addressed in the catch-up process, and how can private actors efficiently contribute to the development of the institutional environment without resorting to self-serving behaviors?

We suggest that we have provided at least a partial answer to this question through a historical analysis of the Finnish pulp and paper industry catch-up, a process that spanned almost the entire 20th century. Central to the catch-up process was an industry-wide nonprofit R&D alliance that was spearheaded exclusively by private actors but where private interests were tempered by explicit governance structures, and primary attention was thus directed to sectoral interests. Ultimately, what started as an R&D alliance developed into much more than a vehicle for the development and dissemination of technology; it ultimately became one of the central institutional architects. We submit the alliance as an illustration of the symbiotic relationship between the technological, economical, and the political subsystems. Our study in many ways verifies Malerba and Lee's (2021: 989) notion that such "positive congruence" is central to successful catch-up and economic growth.

Acknowledgements

The authors would like to thank the participants of seminars at SPRU, Tampere University, University of Jyväskylä and IE University for helpful comments. Moreover, help with data access and contextual information by Timo Lehto and Jan-Erik Levlín is gratefully acknowledged.

Funding

Research Council of Finland (grant numbers 342980 and 355246).

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