

PAPER-MAKING MACHINES AND MICROCHIPS: A COMPARISON OF THE BASQUE PAPER AND
ICT CLUSTERS' LIFE CYCLES

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Abstract: This paper discusses the results of an ongoing research project on the historical origins of industrial clusters in the Basque Country. In this manuscript we aim at examining when and how two of those clusters (paper and ICT) created and developed their competitive advantage. This comparison between two clusters permits us to identify common factors determining the evolution of different clusters in order to explain why several clusters arise in a region. On the other hand, we also identify elements that explain a different evolution of the two clusters. We also discuss policy implications of our findings.

Keywords: clusters, competitive advantage, life-cycles.

JEL classifications: L52, O12, O33, O38.

INTRODUCTION

The importance of clusters and spatial networks for economic development has been largely acknowledged in economic and business literature (e.g., Porter, 1998; Martin & Sunley, 2003; Malmberg and Maskell, 2002). Empirical evidence shows that companies in clusters experience stronger growth and faster innovation than those outside clusters and that clusters attract more start-ups than regions without a cluster (Audretsch and Feldman, 1996; Baptista and Swann, 1998; Baptista, 2000; Klepper, 2007; Swann et al., 1998;). These characteristics cause clusters to be considered a prerequisite for regional prosperity (Porter, 2003; Bathelt, 2001). Many policy makers also recognized this issue and turned to policies based on cooperative networks (Aranguren et al., 2006).

The Basque Country was among the earliest regions in the world in developing a cluster policy (Ketels, 2004). During the early nineties, when the region was immersed in an economic recession, the Basque Government pioneered a competitiveness policy based on clusters (see, for example, Iturrioz et al., 2005; Azua, 2003). At the moment, 13 Cluster Associations are operating in the Basque Country, including aeronautics, audiovisual, automotive, home-appliances, energy, machine tool, environment, paper, maritime, Bilbao port, ICT, and transport and logistics. These clustered companies mean about 40% of the industrial employment and more than 10% of the total employment in the region.

Both at the theoretical and empirical level, much of the existing literature focuses on understanding the existence and functioning of contemporary successful clusters (Bergman, 2007). In this attempt, many factors that define the clusters are detailed in the literature. Michael E. Porter (1990), for example, built a diamond model for cluster competitiveness,

while Maskell (2001) contributed to this literature with a knowledge-based theory of the cluster. However, economic advantages that stem from cluster dynamics are not permanent (Grabher, 1993) and factors explaining the present functioning of the cluster may not explain its evolution. The few existing insights on the emergence of clusters, for example, lead to the conclusion that the processes responsible for the functioning of a cluster cannot explain its emergence (Orsenigo, 2001; Bresnahan et al., 2001). Also, the decline of clusters seems to be caused by factors that were advantages in the past (Martin and Sunley, 2006; Jacobs, 1969). This leads Maskell and Kebir (2005) to observe that cluster theory remains incomplete and possibly misleading in the absence of life-cycle considerations. Similarly, several authors have recently highlighted the need to understand how and why clusters actually become clusters, and how do they develop and decline (Feldman 2001; Feldman et al., 2005).

Same problem holds for the case of the Basque Country. On the one hand, most of the existing literature at cluster level analyzes functioning of contemporary clusters and evaluates the efficacy of Basque Government's cluster policy in recent years (e.g., Aranguren et al., 2005). On the other hand, although economic historians have explained the long-term evolution of different industries in the Basque Country, they have not employed a cluster perspective, nor they do analyze why these clusters were born in the Basque Country and which factors explain their evolution over time.

In this paper we employ a 'history-friendly model' (Malerba et al., 1999) of cluster evolution to analyze and compare the life cycle of two of the Basque clusters, paper and ICT, supported by empirical evidence of in-depth case studies (López et al., 2008; Valdaliso et al., 2008). Each of these clusters concentrates about 20% of Spanish activity in the sector. According to the last available data, at present the paper cluster employs about 5,000 people, including both direct

and indirect employees, and generates about 1,200 million euro of turnover. The ICT cluster, on the other hand, is comprised of 312 firms, employs 14,700 people and generates 3,916 million euro of turnover. Exports represent about 30% and 21% of total production of each cluster, respectively. Based on the cluster life cycle stages described in the literature (Bergman, 2007; Menzel and Fornahl, 2007), we analyze which factors determine the emergence of each of those clusters in the Basque Country and how do cluster competitiveness factors change as clusters evolve along their life cycle. We compare both clusters trying to identify common and divergent factors explaining the evolution of both clusters. Finally, we discuss implications of our findings for policy makers.

CLUSTER LIFE CYCLES

Cluster life cycles are usually represented as “S” curves, with quite similar terms of reference to those of the industry-, technology- and product-cycles (Bergman, 2007). Clusters follow a kind of life cycle with different phases or stages. Several authors distinguish three phases in this life cycle. For example, Klepper (1997) distinguishes between embryonic, growing and mature phases, while Maskell and Kebir (2005) use the terms “existence”, “extension” and “exhaustion” to describe specific cluster life-cycle stages. In contrast, some other authors separate cluster life-cycles in four stages. Van Klink and De Langen (2001), for example, describe the cluster cycle as a progression through the phases of development, expansion, maturation and transition. Similarly, Menzel and Fornahl (2007) describe cluster evolution in terms of emergence, growth, sustainment and decline. Bergman (2007), on his part, distinguishes between two sub-phases in the extension phase: exploratory expansion (early development and expansion of the cluster) and exploitative expansion (its ability to exploit opportunities, attain hyper-growth and engage in scale-expansion).

Cluster life cycles are usually characterized in terms of their evolution in number of firms, employment and output (e.g., Swann et al., 1998). During the emergence, the cluster is not actually a cluster, but the basis for the cluster and subsequent growth are generated. Despite some small agglomerations, in this stage there are a limited number of often quite small companies, with few employees and small output (Menzel and Fornahl, 2007). Once the cluster is born, moves between cluster cycle phases result from gaining new or losing old agents (mainly firms), shifts in the scale and scope of activities among incumbent firms, or both (Menzel and Fornahl, 2007). Accordingly, one of the main factors that turn an emerging cluster into a growing one are pervasive start-up and spin-off processes (Arthur, 1994; Feldman et al., 2005; Klepper, 1997), that result in strong increase in employment (Menzel and Fornahl, 2007), and high output growth (Klepper, 1997). During the sustainment phase the cluster is able to maintain its employment on a high level. Finally, in the exhaustion phase, both the number of companies and employees diminish due to failures, mergers and rationalizations. Start-ups are rare during this phase (Menzel and Fornahl, 2007).

However, these quantitative ex-post indicators are not sufficient to explain the emergence and development of a cluster (e.g., Bresnahan et al., 2001; Menzel and Fornahl, 2007). They do not explain why clusters emerge and why do they experience certain evolution. Some authors establish the relationship between industry and cluster life cycles; they consider that the life-cycle of a cluster cannot be considered in the absence of its core industry life-cycle (Bergman, 2007). Clusters begin to emerge as the industry grows. At first glance, it seems that clusters follow the life cycles of their industries. Seen this way, the cluster life cycle is only the local expression of the industry (Menzel and Fornahl, 2007). However, empirical studies indicate

that the life cycles of clusters and industries may be different, as different clusters that belong to the same industry life cycle can follow different growth paths (e.g., Saxenian, 1994).

Insights on the emergence and development of clusters are also given by studies with a micro-oriented perspective, specially the “diamond” model presented by Michael E. Porter (1990). According to this author (Porter, 1998), a cluster’s roots can often be traced to parts of the diamond that are present in a location due to historical circumstances. One outstanding reason for the early development of a regional cluster is the availability of pools of factors (inputs), such as specialized skills, university research expertise, an efficient physical location, or particularly good or appropriate infrastructures. Second, cluster may also arise from unusual, sophisticated, or stringent local demand. Third, prior existence of supplier industries, related industries, or entire related clusters may also ease the establishment of a new cluster in a region. Fourth, new clusters may also arise from one or two innovative firms that stimulate the growth of many others. Finally, Michael E. Porter states that chance events and government policies may also be important for the birth of a cluster.

Some other authors also use similar terms to highlight the importance of historical legacies and regional particularities for the emergence of a cluster. Boschma and Wenting (2007), for example, claim that locations with older but related industries have a higher likelihood of forming a cluster. Likewise, Jacobs (1969) states that for the generation of new companies and industries “new work is added to older work”. Based on a literature review, Bergman (2007) highlights that pre-existing community values such as entrepreneurship, cooperation and social capital, and common work ethics play an important role in the emergence of a cluster.

Once the cluster is born, the development process heavily depends on the efficacy of the diamond's arrows or feedback loops. Once the cluster reaches a critical mass, the emergence of positive externalities, knowledge spillovers, increasing returns to scale and agglomeration economies impel the growth/extension of the cluster, as additional firms are attracted to the cluster (Lorenzen, 2005). Two particular areas deserve special attention: first, the location's overall environment for new business formation, both the entrepreneurial climate of the region and organizations that support start-ups; second, the efficacy of formal and informal mechanisms (i.e. social networks) for bringing cluster participants together, and facilitating mutual acquaintance, development of trust relations, collaboration, and dissemination and exchange of information (La Porta et al, 1997; Breschi and Malerba, 2001; Feldman, 2001; Feldman et al., 2005).

Bergman (2007) distinguishes between two sub-phases within the growth stage of the cluster. The exploratory expansion stage is characterized as "entrepreneurial technological regime" (Winter, 1984) that is favourable to innovative entry, but unfavourable to established firms. On the contrary, the exploitative expansion stage is characterized as "routinized technological regimes" (Winter, 1984). Due to the learning processes, companies reduce their technological distances. This convergence makes further collaboration possible, along with a division of labour and a specialization of the companies and accompanying opportunities for increasing returns (Klepper, 1997; Maskell and Malmberg, 1999; Menzel and Fornahl, 2007). This phase is often aided by the deliberate policies dedicated to the improvement and expansion of beneficial advantages (Bergman, 2007). Improving supportive infrastructures and cluster organizations are established to fulfil and lobby for the fulfilment of cluster's needs (Menzel and Fornahl, 2007).

Declining clusters are often mono-structured “company towns” with too little heterogeneity and diversity to generate new ideas (Jacobs, 1969). There is a strong cluster-oriented bias of economic activities: specific knowledge base, highly qualified and specialized employees and companies strongly focused on specific markets and technologies. Clusters enter into the exhaustion stage when they lose their ability to adjust to a changing environment, by integrating new and often external knowledge. Causes of cluster atrophy and decline can be grouped into two broad categories: endogenous, or deriving from the location itself, and exogenous, or due to developments or discontinuities in the external environment (Bergman, 2007; Porter, 1990; 1998). Thus, some of the factors described at the exploitation phase are responsible for effectively locking a cluster or region into an exhausted sense of possibilities (Grabher, 1993). On the one hand, overconsolidation, too much inward orientation, mutual understanding and too-tied local connections, groupthink, cartels, restrictive union rules, regulatory inflexibility, and excessive dependence upon non-firm agents and compensatory support (political lock-ins that deny market viability issues) are among the most important endogenous motives for cluster decline. On the other hand, technological discontinuities, deteriorating factor conditions, and shifts in buyer’s needs are amongst the most important external causes for cluster decline. According to Bergman (2007), such factors anesthetize cluster agents, reducing their ability to recognize and make timely adjustments to fundamental changes brought on by radically altered markets, technologies and vibrant new global competitors. At some point in time, the global firm population and their supply increase faster than demand. As a consequence, competition becomes fiercer and finally leads to an increasing occurrence of shakeouts (Brenner, 2004).

A declining cluster has three different possibilities: (1) the cluster simply diminishes; (2) after a temporary period of lock-in the cluster experiences a renewal of the existing development

path through the implementation of new, yet related technologies, often from other locations;
(3) transition toward completely different fields (Menzel and Fornahl, 2007).

In sum, in previous paragraphs we first explained cluster life-cycle stages in terms of their principal numerical indicators (i.e. number of existing firms and employment). After briefly reviewing the relationship between industry and cluster life-cycles, we highlighted some aspects that can determine the birth, growth and decline of cluster. We mainly focused on the four factor groups identified in Michael Porter's diamond to build our explanation: factor (input) conditions, demand conditions, related and supporting industries, and context for strategy and rivalry. In the next paragraphs we analyze the life cycles of two clusters in the Basque Country: paper and ICT. For each of the clusters, we analyze different stages on their life cycles. In doing so, we explicitly analyze the above mentioned variables in each of the stages of the cluster life cycle. Moreover, we also consider knowledge heterogeneity (diversity) and social (relational) capital in each of the phases.

BASQUE PAPER CLUSTER

1. Emergence of the cluster (c. 1800-1841)

The origins of the Basque paper industry can be traced back to the later 18th century. The triggering effect was local demand, playing card manufacturers Together with local demand, a highly significant factor was the bountiful hydraulic resources of the region. This region, however, did not enjoy other advantages, such as the availability of qualified labour and entrepreneurship. Nevertheless, this resource, together with technology, was readily imported from South Western France, which already had an advanced manufacturing tradition.

In sum, this early phase gave rise to the Basque paper industry mainly due to local demand. Number of firms in the region was still low, with few people working in the cluster, the degree of firm rivalry was still low and related and supporting industries were not developed. Knowledge diversity is scarce in this phase, and relational capital is not developed.

2. Exploratory expansion (1841-c.1900)

This phase was marked by two changes in factor conditions: the diffusion of paper-making machines (Fourdrinier technology) and improved transportation and communications – that enhanced the advantage of location and made it possible to increase the available market and conferred better and cheaper access to imported raw materials (coal and wooden pulp). Local and French entrepreneurs pioneered the introduction of new technology in the Basque Country, to serve a regional and national market protected by State tariffs. Market growth during the second half of 19th century spurred an increase in production capacity in existing businesses and the creation of new companies both by local and foreign entrepreneurs, which helped to generate greater rivalry. At the same time, the regional concentration of the majority of the firms in the district of Tolosa also generated economies of agglomeration, knowledge spillovers as well as a favourable context for cooperation among firms (i.e. increasing relational capital). The first related and supporting industries that arose, such as printing and machine repair, started to be set up during this period. As new activities are introduced in the cluster, knowledge heterogeneity (diversity) is also increasing.

3. Exploitative expansion (c.1900 – 1936)

In the early 20th century, a structural change took place in the sector. As consumption and national market size grew – still relatively safeguarded from foreign competition – the average size of companies grew. This was, on the one hand, the result of merges and, on the other hand, of the founding of new companies of a significantly greater initial size. Yet, this process of concentration still did not have a significant effect on competitiveness and prices.

All this brought about a new auxiliary industrial sector for the repair and, later, the production of machinery, as well as improvement in labour skills (training colleges that were fostered by the industrial sector) and capital (better market and capital operation, as well as new credit institutions).

The competitive advantage of the region at the end of this period, the first producer of Spain with roughly half of the productive capacity, can be attributed to the combination of good supply conditions (which improved with respect to the previous period), firm structure and strategy, competitive rivalry in the midst of a stable institutional environment that fostered commercial initiative, improved training and innovation. Within the paper districts, proximity and local know-how generated a climate of trust (i.e. relational capital) that yielded lower information and transaction costs, which, in turn, led to strategies of specialization.

4. Sustainment (c. 1950 – 1975)

Extreme regulation and autarchy marked the 1940s and 1950s. During this period, the vertices of the diamond had poorer characteristics than in the previous phase. The impossibility of importing raw materials and the consequent rise in the costs worsened the factor conditions. In addition, even though new commercial policies spurred the creation of new companies, the

impossibility of importing machinery stunted growth and did not help to generate competitive rivalry among companies in the sector. To make matters worse, demand weakened.

From 1959 until 1975, commercial liberalization of Spanish economy, which opened the road for acquiring raw materials and modern machinery, and a growth in internal demand lead to considerable growth in the Basque paper industry. New institutional conditions during this period inspired companies to adopt a strategy of continuous investment in the renovation and upgrading of production machinery. It is a case of transition from a factor-based to an investment-based economy.

After 1960, there was a considerable development in the machinery and auxiliary sector, spurred in part by local companies, but also thanks to the liberalization of equipment, capital and technology imports. Also during this period, the demand for increasingly qualified professionals led to the creation of the Tolosa Paper College, which continues to operate today (2008). The most notable weaknesses in the Basque paper cluster at this time were the small size of companies in a sector in which economies of scale were becoming increasingly important, an almost exclusive dependence on internal markets that were relatively safeguarded from foreign competition (that is, companies with virtually no international experience) and a deficient internal commercial network, although a steady increase in imported paper did offset this tendency to some extent and some competitive rivalry could be detected.

5. Decline (c. 1975 – 2008)

The last three decades have been affected by the institutional changes that took place during the transition and the implementation of new economic guidelines that opened Spain to the world. The process of internationalization, which was accelerated by the incorporation of Spain in the European Economic Community (EEC) in 1986, had an effect on several aspects, in particular factor conditions and demand.

The internationalization of the sector soon conferred Basque companies with improved access to raw materials at lower prices, although Basque companies and companies in other regions around the world are faced today with scarcity and subsequent rise in the cost of raw materials brought on largely by the increase in Chinese demand. This situation is further worsened by high energy costs and increasingly severe environmental restrictions.

Access to foreign markets has made it possible to increase exports considerably, although facing intense competition abroad. As well, a situation of excessive supply in the European market has given rise to great rivalry in the paper sector, coupled with price/cost competition. The internationalization of the sector served to increase awareness of the importance of economies of scale and the size factor in order to compete in a global economy. The survival of companies depended on three closely linked strategies: reduced product range (specialization), renovation of the means of production (new investments) and the need to be internationally competitive. Some companies were absorbed into larger groups in an attempt to gain in size and resources, while others opted for capital and foreign know-how. Others simply ceased to exist. Companies closing down and the formation of large trade consortiums seem to be the basic tendencies in the paper sector around the world today. At any rate, Basque companies are generally too small and Spain's productivity is still lower than most of its European neighbours. To make matters worse, the machinery in many of the plants is

obsolete. Therefore, pulp and paper producers are having difficulties in specializing due in part to their lack of innovative spirit. On the contrary, equipment manufacturers are investing heavily in R&D and new technological development that differentiate them from their competitors. In fact, some of the equipment manufacturers are world class and their equipment is used in plants around the globe.

In sum, the study of the Basque paper cluster is an example of a declining cluster. This example illustrates that the economic advantages that stem from cluster dynamics may not be permanent. Most of the competitive advantages that the cluster gained during the previous period are now easily attainable in other regions. As a result, the Basque paper cluster is losing ground. During the last years, several paper mills closed down and the cluster is changing its focus from paper production to paper machinery production. In fact, the decline of the cluster seems to be caused by factors that were advantages in the past (Martin and Sunley, 2006).

BASQUE ICT CLUSTER

1. Emergence (c. 1950 – c. 1975)

The origin of the Basque electronics industry in the late 1940s was due to the confluence of various demand and supply factors. On the one hand, there was a local demand for electronic products and solutions, protected by tariffs, coming from the national electric utilities companies and other regional industries. On the other hand, the Basque Country had favourable factor conditions for the emergence of the industry. The emerging cluster could count on a relatively well qualified labour force, trained in regional technical schools and

universities (engineers). These founding firms were created by local entrepreneurs, with different technical backgrounds, who imported and transferred foreign technology.

From the 1960s, the great majority of the firms committed themselves to catch-up with the technological leaders, to improve the imported technology, and to develop their own products and solutions with proprietary technology, granting independence from their former foreign licenses. Local initiative, together with central government support, resulted in the creation of technological centres linked to firms, universities and industry associations.

Since the late 1950s some engineering firms were born. There is no evidence for intense connections between these companies and electronics firms in these early stages of the cluster development. However, these firms played an important role in the definition of the products and solutions to be installed, especially in the electrical utilities companies.

2. Exploratory expansion (c. 1975 – c. 1996)

A technological break-up marked this period: the bursting in of the microelectronics and the chip and transition from analogue to digital technologies. The existing firms augmented their national market share. They continued their strategy of developing a proprietary technology. In order to achieve that, they invested large amounts in R&D activities, setting up R&D centres and/or laboratories. In this period firms also started their internationalization process, with increasing exports and the first foreign plants. Apart from these existing firms, new firms were also created, both in the existing sectors and in other related ones (what increased the cluster's knowledge heterogeneity). Some of these firms were completely new; others were

spin-offs of existing companies. The dynamics of new firm formation in a context of high uncertainty and technological change augmented firm rivalry and competition.

Clustered firms benefited from favourable factor conditions. On the one hand, first promotions of physicists specialized in electronics and automatics (1976) and computer engineers (1980) graduated in Basque universities, pioneers in both studies in Spain. On the other hand, besides being an important demander for computer services, the banking sector provided financing for firms in the cluster.

Finally, government played an important role in this exploratory expansion phase. Some governmental measures, in particular PIE (a R&D program of Spanish Ministry of Industry), tightened collaboration between big electric utilities firms and electronics firms. As a result of the collective learning and cooperation strategy put forth by Basque Government, firms and technological centres, the ICT cluster was born in this period. The starting point was the creation of AIEPV in 1983 (initially, an industry association), promoted by SPRI (a Basque Government agency), and the technological policy programs designed by SPRI such as IMI (1983) and PET (1990). The cooperation strategy propelled from AIEPV and the regional government (in aspects such as R&D and cluster policy), was strengthened by the existence of a network of scientists and engineers with a common knowledge base and the progressive localization of many firms and technological centres in business and technological parks. Collaboration among firms, universities and technological centres materialized in training programs (postgraduate studies in electronics, automation, computing and telecommunications), joint participation in R&D programs and projects and internationalization. Despite this collaboration, rivalry among cluster firms remained high in this period. This was in part due to the creative destruction process in the sector (high firm

birth and mortality rates) and to the abundance of spin-offs. Collective learning in a context of change and technological uncertainty and entrepreneurial activity explain increasing cluster heterogeneity, with new firms offering innovative products and services.

3. Exploitative expansion (c. 1996 - ...)

Exploitative expansion phase of the cluster was determined, to a great extent, by the incorporation of new activities to the cluster (computing and software, telecommunications and content industries), and the challenges of globalization. The incorporation of new sectors reinforced the diversity/heterogeneity of the cluster, but also demanded greater coordination and collaboration efforts. Clustered firms continue to collaborate in R&D activities, training programs and internationalization. The former AIEPV transformed this year into GAIA, a cluster association, which also promoted the collaboration with other clusters, with uneven results. At the same time, rivalry continues, due to new firms creation and spin-off dynamics, and pressure derived from the progressive and unstoppable internationalization of the industry, both in terms of supply and demand.

Most experienced and biggest firms started a proactive strategy to increase their size, offer integral solutions, reinforce R&D strengths and internationalize. Firms counted on Basque governments' support and an already consolidated research infrastructure (universities, technological centres and parks). In some cases, the internationalization of Basque firms was hand in hand with that of Basque and Spanish engineering firms, electric utility firms or construction companies.

A COMPARISON BETWEEN THE TWO CLUSTERS

The two clusters analysed above present remarkable differences between them. On the one hand, life cycles and technological regimes of both industries differ significantly. On the other hand, the life cycles of both clusters are also divergent. Despite those differences, the comparison between both clusters enables to put forward some interesting hypotheses about:

1. Factors that explain the emergence of clusters.
2. The role of the four vertexes of Porter's diamond in the competitiveness of both clusters.
3. The role of Governments and States.

We formulate the hypotheses in general terms, evaluating the whole trajectory of the clusters.

We do not make a comparison for each phase of the cluster life cycles.

1. Factors explaining the emergence of both clusters

Our historical research enables to clearly set which factors were responsible for the emergence of both clusters. In both cases, the origin of the cluster was due to the initiative of Basque entrepreneurs who discovered and exploited new business opportunities, associated with a technology and/or a market. That initiative benefited from favourable factor conditions (natural resources and qualified labour force) and a regional-national demand that was quite protected from international competition. These two factors are sufficient to explain the emergence of the paper cluster in the middle of the nineteenth century, in a historical context where the Basque Country and Catalonia were leading the takeoff of the industrial revolution in Spain, which was economically backward and not very integrated into the international economy. The earliest firms devoted to the electronic technologies were born in the Basque

Country about one century later, in the late 1940s and early 1950s, and are the fruit of the initiative of relatively well trained entrepreneurs who introduced, imitated and copied foreign modern technology but also, very quickly, developed a proprietary technology. Qualified labour force in the region and a relatively complex and sophisticated regional and national demand for electronic products and solutions were at the disposal of these firms. Besides, almost from the beginning, the electronics cluster counted on the contribution of the other two vertexes and the government's support through policies on labour qualification and R&D promotion.

Thus, entrepreneurship played a very remarkable role in the emergence of both clusters (Bresnahan et al., 2001; Feldman, 2001; Feldman et al., 2005). However, the different technological regime of each industry (with a knowledge base that was more complex, heterogeneous and intensive in science and knowledge in electronics) (Malerba and Orsenigo, 1993) and the different type of demand (final and standardized consumer products in paper; intermediate products and technologically more varied, sophisticated and demanding solutions in the case of the electronics cluster) (Malerba; 2006; Malerba et al., 2007), and their implications for different vertexes of the competitiveness diamond in each cluster explain to a large extent the different trajectory that they are following in the future.

2. The role of the four vertexes of Porter's diamond

Factor conditions: Although it was the availability of production factors in the region one of the determinants of the cluster's origin in both cases, the pressure of the increasing globalization and a more intense factor mobility explain that only those clusters that developed more specialized and difficult to imitate factor conditions are able to maintain their competitiveness

in a more and more global economy (Porter and Sölvell, 1997). Undoubtedly, the technological regime of the industries involved in each cluster, defined in terms of complexity and heterogeneity of the knowledge base and the conditions of generation and appropriability of innovations plays a decisive role in the evolution of the cluster (Malerba and Orsenigo, 1993). The electronic technology is more knowledge- and science-based than the paper-making one. It is more R&D intensive, with a more heterogeneous knowledge and a greater diversity of related industries and sectors, and shows far more interaction between suppliers and clients. Because of that, it is much more open to the collaboration between firms and more disposed to the generation of relational capital, more regional specific and difficult to imitate.

The paper cluster based its competitiveness in natural resources (water above all), physical capital (modern technology) and human capital (qualified labour force), but these factors ended up being imitated by competitor regions with lower labour costs, threatening the sustainability of the cluster. On the contrary, the electronics and ICT cluster, with a more complex and heterogeneous knowledge base, was able to move its competitiveness towards a type of knowledge based not only on physical and human capital, but also on social and relational capital that ties the different vertexes of the regional competitiveness diamond creating very particular and sustainable advantages (Porter and Sölvell, 1997). This relational capital, based on geographical proximity, proactive performance of the cluster association, social networks of college graduates and researchers and a high mobility of qualified human capital, ties firms (in the cluster and related sectors), universities and technological centres, clients (regional and national) and governmental institutions, developing a dynamic of collective learning and continuous innovation (Keeble and Wilkinson 1999; Keeble et al., 1999; Capello and Faggian, 2005).

Demand conditions. Firms in the paper cluster benefited during more than a century from a relatively captive demand (protected by tariffs from international competition) of relatively simple and standardized products (press paper, of low quality, where cost is relevant; and printing and writing paper, of medium-high quality, where competition is on price and quality) that only began to open to international competition from the decade of 1970. The protected nature of the market weakened the competitive rivalry that existed among firms.

On the contrary, firms in the electronics cluster benefited from an intermediate demand of relatively complex and sophisticated products and solutions, a less standardized and more experimental demand, and the demand of new segments and market niches. This type of demand is much more demanding in terms of R&D and contributes decisively to explain the innovative strategy of the cluster firms (Malerba 2006; Malerba et al., 2007). The existence of experimental customers and new market niches not only gives an incentive the innovation of offering firms, it also requires a greater collaboration and interaction between the producers and their clients, contributing to the formation of relational capital in the cluster. Lastly, unlike firms in the paper clusters, a great majority of the firms in the electronics cluster (all of the created since the 1980s), came up in a market that was open to international competition and in a sector characterized by a large turbulence and by creative destruction (high levels of competitive rivalry), where the only way to compete was innovation.

Firm strategy and rivalry also presents significant differences in both clusters, in part due to the different technological regime of each industry, but also due to the different demand conditions. As it was already stated, firms in the paper cluster were created to supply the regional-national market protected from foreign competition. They based their competitiveness in cost advantages (large firms with economies of scale) or in product quality

(small and medium firms), availability of qualified labour force and modern technology plus increasing returns to scale associated to the agglomeration economies developed in the region of Tolosa, and, to a lesser extent, in the valleys of Biscay. But the production for the national market made that the average size of the firms was smaller than of the competing nations, decreasing earning derived from economies of scale, and that competitive rivalry was smaller. The opening of the Spanish economy to the international market and globalization increased competitive rivalry but also eroded the competitive advantages of the Basque paper producers. Although a variety of collaborative initiatives emerged (trade and research associations), they limited themselves to a national scope and never obtained significant results. Only recently (1998) a cluster association, Clusterpapel, has been created in the Basque Country.

On the contrary, the great majority of the electronic cluster firms emerged in an economy open to international competition and in an industry life cycle characterized by extremely low barriers to entry and an intense turbulence (entry and exit of firms) associated to a dynamic of technological change and breakup, high uncertainty and innovation. Besides, almost from the beginning, a trade association existed, which later became a cluster association. This association, supported by the regional government, developed a proactive strategy for inter-firm collaboration, particularly successful in three areas, qualified labour force training, R&D activities and internationalization. Firms in the cluster are open to relationships with other firms (competitors, clients, suppliers) in the region, but also worldwide, which has impeded isolation or insularity of the cluster up to date. The increasing internationalization made that the biggest firms formed larger and more diversified business groups.

Cluster's knowledge heterogeneity and existence of related and supporting industries and services. Both clusters also show noticeable differences in two closely related variables, heterogeneity and complexity of the knowledge base of the main industries (Malerba and Orsenigo, 1993; Malerba, 2006) and/or the own cluster (Menzel and Fornahl, 2007), and diversity of the own cluster and related and supporting industries and services (Bergman, 2007; Menzel and Fornahl, 2007; Porter 1990).

The paper cluster rested on a knowledge relatively focused on manufacturing paper and paper handling, as well as the knowledge of an auxiliary/related industry, machine production. In fact, in the current context where competitiveness is threatened by the pressure of an increasing globalization, it is this small machine producing subsector which holds strongest competitive advantages and, thus, better expectations for future. On the contrary, the electronics and ICT cluster rests on a knowledge that is much more intensive in science, but also much more heterogeneous, coming from initially different sectors (microelectronics, computer science, telecommunications, and contents industry) that have converged progressively from the 1980s onwards. Besides, firms of this cluster benefited from the existence in the region of producers and distributors of electric energy, engineering firms, and sectors demanding innovative and sophisticated solutions and products (financial sector, automotive auxiliary industry, machine-tool manufacturing...) that frequently ended up being technological partners, joint owners of new firms or allies in various projects and R&D callings.

3. The role of government policies

Finally, there also exist substantial differences in government developed policies. The paper cluster benefited in its origins and earliest phases of a commercial policy that protected the

internal market from foreign competition. However, that policy, kept without significant changes over 100 years, weakened the firms' base of resources and capabilities, as they found themselves obliged to pay more for imported raw materials and technology, and got them used to an environment of low firm rivalry.

Although most recent literature on clusters is sceptical about the driving role of governments, the electronics and ICT cluster enjoyed a support from the national government and, particularly the regional government, decisive. But it is convenient to emphasize that these policies were intended to improve training and qualification of labour force, to make learning and acquisition of knowledge easier, and the creation of research support infrastructures and a collaborative culture among main agents in innovation (firms, universities and technological centres), not to protect, subsidize or intervene the sector (Bresnahan et al., 2001).

CONCLUSIONS

Cases studies of Basque paper and ICT clusters show that along history, both geographical and the institutional environment of the Basque Country have provided good conditions for the emergence and development of industrial clusters. On the one hand, from the beginning of the Industrial Revolution, local factor (input) conditions and demand conditions have driven the emergence of various industrial clusters. Dynamic effects of economic development and industrial concentration from the mid.19th century onwards (i.e. increasing returns to scale, agglomeration economies and positive externalities) brought about a favourable environment to new business formation. On the other hand, during the early 1990s, the Basque Government pioneered a competitiveness policy based on clusters (see, for example,

Aranguren et al., 2005; Azua, 2003). In both cases, the Basque Government and the respective Cluster Association played an essential role in the recent evolution of the cluster.

However, the comparison between the two clusters shows a different evolution and present position of both clusters. The study of the Basque paper cluster is an example of a declining cluster in a mature industry. This example illustrates that the economic advantages that stem from cluster dynamics may not be permanent. Most of the competitive advantages that the cluster gained during the previous period are now easily attainable in other regions. As a result, the Basque paper cluster is losing ground. On the contrary, the study of the Basque ICT cluster is an example of a growing cluster in a set of inter-related young industries.

Both clusters were born in two completely different historical moments; paper cluster emerged in a protected market, while ICT has emerged in an open market. Moreover, both clusters belong to industries with quite different technological regimes and knowledge bases. While the paper cluster was mostly characterized by high investments in machinery, and firms' strategy is based on price and cost competition, the ICT cluster is characterized by high R&D investments and continuous changes in technological frames and firms' strategy is based on product differentiation and innovation. In addition, demand is much more demanding in ICT cluster. Finally, firms in the ICT cluster follow much more advanced strategies, and associationism (relational capital) plays an important role in this cluster.

In sum, the comparison of these two clusters shows that both intra-cluster factors (demand specificity, local resources and entrepreneurship and regional institutions) and extra-cluster factors (technological regime) may explain the evolution of a cluster.

One policy implication that results from the insights in this cluster life cycle analysis is that the same cluster policy will not work for different clusters. Thus, policy makers should, in collaboration with cluster associations, adapt policies to the strategic elements of each cluster (Enright 1998; Bresnahan et al., 2001). However, our comparative study shows that, in general, interventionist and/or protectionist policies have failed in the long-term, while supportive ones, such as those directed to improve education and training and foster inter-firm collaboration and community building have succeeded.

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