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Conference Paper

Do clusters follow the industry life cycle? An exploratory meta-study of Basque clusters from the 1970s to 2008

53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Valdaliso, Jesús M.; Elola, Aitziber; Franco, Susana; López, Santiago (2013) : Do clusters follow the industry life cycle? An exploratory meta-study of Basque clusters from the 1970s to 2008, 53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy, European Regional Science Association (ERSA), Louvain-la-Neuve

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Do clusters follow the industry life cycle? An exploratory meta-study of Basque clusters from the 1970s to 2008

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Abstract

Although clusters life cycles tend to co-evolve with the life cycle of its dominant industry (Bergman, 2008; Menzel and Fornahl, 2010), the stylized life cycle model does not capture the full complexity of cluster evolution (Martin and Sunley, 2011). Empirical studies indicate that clusters do not necessarily follow the life cycles of their dominant industries, as different clusters that belong to the same industry life cycle follow different evolutionary paths (Saxenian, 1994). Thus, clusters are not just a local representation of an industry and local peculiarities also matter for the evolution of a particular cluster (Menzel and Fornahl, 2010). Empirical studies have pointed out that local factors such as factor endowment, entrepreneurship and firms' capabilities, an existing market, or institutions and social capital may have an impact on it (Belussi and Sedita, 2009; Elola et al., 2012).

The Basque Country is an old industrialized European region that successfully managed to escape from a lock-in situation in the 1980s renewing its industrial base by upgrading some of its mature clusters and by promoting new high tech ones. Based on the experience of the Basque Country, in this paper, we aim at analyzing whether clusters co-evolve with their corresponding industry or deviate from it. In addition, we also study which are the local factors that explain such behaviors. For that purpose, we draw on a meta-study of six clusters of the Basque Country: papermaking, maritime industries, machine-tools, electronics and ICTs, aeronautics and energy.

Introduction

The Basque Country was an old industrialized region, specialised in heavy industries (iron and steel, shipbuilding, mechanical engineering), which faced a severe economic crisis and an industrial restructuring in the 1980s. Following Porter's model, in the early 1990s the regional government pioneered within the EU a competitiveness policy based on clusters, with proven and recognized results in R&D, innovation and competitiveness (Ketels, 2004; OECD, 2011; Aranguren et al., 2012; Birch et al., 2010 for a comparative assessment). The Basque Country managed to avoid lock-in situations, renewing its industrial base by upgrading some of its mature clusters and by promoting new high technology ones (Tripl and Tödtling, 2008; Aranguren et al., 2012).

Based on the experience of the Basque Country, in this paper, we aim at analyzing whether the trajectory that clusters follow mirrors that of their corresponding industry or deviates from it. In addition, we also study which are the local factors that explain such behaviors. We specifically consider cluster structure, knowledge base and absorptive capacity, social capital, and public policies.

The empirical base of this paper draws from in-depth case studies on six industrial clusters: papermaking, maritime industries, machine tools, electronics and information and communication technologies (ICTs), aeronautics, and energy. For each cluster, the research team conducted a historical (longitudinal) and qualitative in-depth case study, based on different sources of information, in order to obtain stylized facts from which we can infer more general propositions (for a similar methodology, see Bresnahan et al., 2001; Feldman, 2001; Shin and Hassink, 2011). After that, we employ a qualitative meta-study approach, akin to that conducted by Van der Linde (2003) for world clusters and by Belussi and Sedita (2009) for Italian industrial districts in order to summarise the knowledge gathered in the case studies.

The paper has five parts. In the first one, we discuss the theoretical literature on cluster life cycles and present the analytical framework we have developed to classify cluster trajectories in relation to the trajectories of their corresponding industries. Then, we explain in part two the methodology and data employed, along with a presentation of the six clusters studied. This is followed by a stylized analysis of the evolution of every cluster's competitive position from the late 1970s to 2008, when the current crisis started, in part 3. Afterwards, in part 4, we discuss how local factors have contributed either to adjust such evolution to that of the industry or to make it possible for the cluster to escape from a declining phase of an industry. Finally, we offer some conclusions and policy implications.

1. Cluster life cycles: beyond the industry life cycle

Like a product, an industry also follows cyclical development patterns. Klepper (1997) distinguishes three different stages of an industry life cycle: an embryonic stage with small output, a growing stage, and a mature stage with a decline in the number of companies and employees. This seems to indicate a deterministic industrial path.

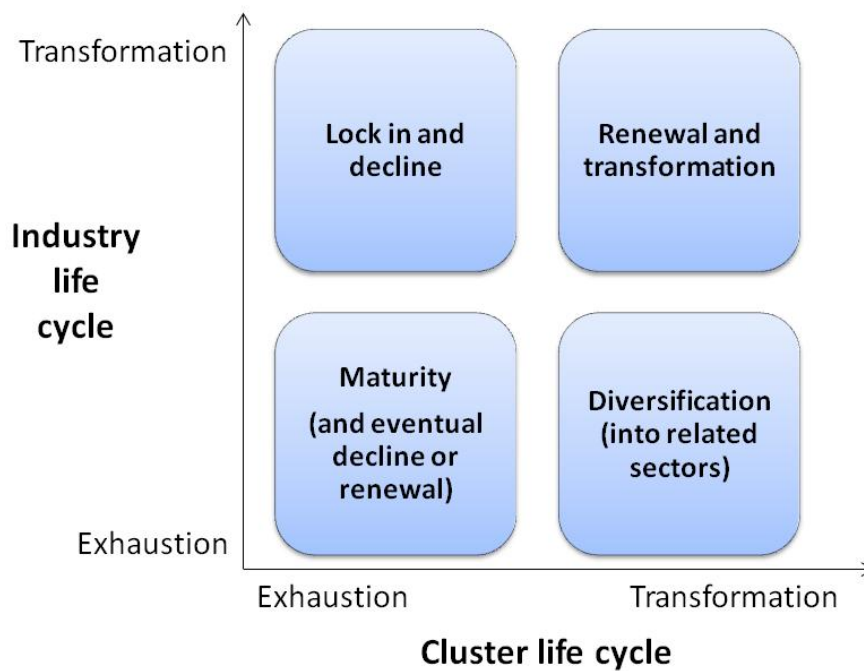
However, similarly to what has been described for cluster life cycles (Menzel and Fornahl, 2010), industries might also be able to adapt or renew themselves.

At first glance, it might seem obvious that clusters life cycles tend to co-evolve with the life cycle of its dominant industry (Bergman, 2008; Menzel and Fornahl, 2010). The cluster life cycle, then, would only be the local expression of its industry (Martin and Sunley, 2011). However, empirical studies indicate that clusters do not necessarily follow the life cycles of their dominant industries, as different clusters that belong to the same industry life cycle follow different evolutionary paths (Saxenian, 1994). That is, some clusters are able to escape from the tyranny of the industry life cycle and from lock-in situations while others cannot. And the same goes for the regions where these clusters are located (Martin and Sunley, 2006 and 2011; Martin, 2009). Martin and Sunley (2006) have suggested several possible scenarios of escaping from lock-in: indigenous creation, heterogeneity and diversity, transplantation (of a new industry or technology) from elsewhere, diversification into technologically related industries and upgrading of existing industries. Trippel and Tödtling (2008), in particular, propose three types of cluster-based renewal for old industrial regions, related to three distinct regional development paths: incremental change (innovation-based adjustment of mature clusters), diversification (new clusters in established industries) and radical change (new high technology clusters). These types may coexist within a given region.

Following the above discussion, we have opted for displaying the co-evolution of industry and cluster life cycles from their maturity stage (which would describe an industry/cluster facing the threat of exhaustion and disappearance) to other possible stages with different degrees of renewal and/or transformation (see Figure 1). Four distinctive paths for mature clusters in old industrial regions can be identified:

- *Maturity (and eventual decline or renewal)*: clusters follow the life cycle of the dominant industry that is not able to change (although it might change in the future).
- *Lock-in and decline*: some clusters are not able to adapt to the evolving technological trajectory of the dominant industry (because their firms' capabilities do not allow them to follow dynamics of rapid technological change), and consequently they become locked-in, decline and eventually disappear.
- *Renewal and transformation*: clusters are able to adapt to the evolving technological trajectory of the dominant industry by renewing and/or transforming their knowledge base, in a process that goes hand in hand with the technological evolution of the dominant industry.
- *Diversification*: clusters are able to escape from declining industries by applying their knowledge base to enter into related (and more dynamic) sectors.

Figure 1. Co-evolution of industry and cluster life cycles



Source: authors' elaboration.

Thus, clusters are not just a local representation of an industry and local peculiarities also matter for the evolution of a particular cluster (Menzel and Fornahl, 2010; Martin and Sunley, 2011). Although it is widely recognized that cluster life cycles can differ from their dominant industry and/or technology life cycles, currently there is little empirical research addressing how and why the life cycles of clusters differ from those of industries.

Based on existing literature (Belussi and Sedita, 2009; Brenner and Muhlig, 2007), in a previous paper we analysed which factors determine cluster emergence and evolution (Elola et al., 2012). In each case, we considered both factors that are endogenous and exogenous to the territory where the cluster is located (local and global factors, respectively). Regarding cluster emergence, among the local factors we distinguished a category of historical legacies (tradition and historical preconditions), another category related to regional factor endowment (natural resources, qualified labour, infrastructure...), and some triggering elements (local demand, local and national policies, and anchor firms and local entrepreneurship (see Brenner and Muhlig, 2007; Belussi and Sedita, 2009; and Elola et al., 2012, for further discussion). We also considered global factors, such as the entry of foreign firms and entrepreneurs, with capital, technology and/or knowledge. Additionally, we also took into account the role of international demand growth as a triggering factor for the emergence of a cluster.

Regarding cluster development, among the local factors, we distinguished one category related to the cluster prior trajectory, where we consider the development of factors specific to the cluster; another one related to the development of capabilities by cluster firms (strategic capabilities in strict sense, and dynamic capabilities); and two other referred to other local agents (local sophisticated demand and local/national policies) (see Elola et al., 2012, for a more detailed discussion).

Globalization (in the form of internationalization, entry of MNEs, relocation processes) can also play an important role in cluster evolution. It is considered one of the most difficult challenges for clusters today (Belussi and Sedita, 2009; Warrian and Mulhern, 2009). The absorption of extra-cluster knowledge, and the interplay between intra- and extra-cluster knowledge systems gain special importance for the sustainment of cluster competitive advantage, avoiding cluster insulation or myopia (Giuliani, 2005; Maskell and Malmberg, 2007). Cluster leading firms, PROs and cluster associations may act as technological gatekeepers of extra-cluster knowledge, which they channel into the cluster. Actors from outside, too, such as MNEs, can also drive the inflow of external knowledge into a cluster (Giuliani, 2005; Valdaliso et al., 2011).

Although there are already some approaches to explain the progress of a cluster through its life cycle, it is not clear which influences stem from cluster internal dynamics and which from industry and/or technology trajectory. Specially, as Menzel and Fornahl (2010) highlight, it is often considered that cluster life cycles ultimately result in negative lock-in and decline, and the issue of cluster renewal and/or transformation is often neglected (Martin and Sunley, 2006 and 2011). In this regard, the case of the Basque Country is particularly appealing: an old industrialized European region that successfully managed to escape from a lock-in situation in the 1980s renewing its industrial base by upgrading some of its mature clusters and by promoting new high tech ones.

In order to understand how some mature clusters renew and/or transform, while some others decline, in this paper we take the exogenous factors (e.g., technological change and globalization) for granted, and focus instead on the local factors. Following our previous works and that of Trippel and Tödtling (2008), we specifically consider cluster structure (in terms of type of firms and agents, and their business strategies), cluster knowledge base and absorptive capacity (which is related to the firms' strategic and dynamic capabilities), social capital and public policies.

2. Research method and data employed

This paper draws on in depth longitudinal studies on six Basque industrial clusters particularly representative of the industrial development of the region in the 19th and 20th centuries: papermaking, maritime industries, machine tools, energy, electronics and ICTs and aeronautics. By combining a variety of sources and quantitative and qualitative data, we set up the life cycle of every cluster and analysed its driving factors and its competitive position over time.¹

The clusters of maritime industries, papermaking and machine tools have a long history that goes back to the 19th century (and even farther in the first two cases) and have followed an entire life cycle of emergence, development, maturity, and decline or renewal. The energy cluster dates back to the first years of the 20th century, linked to the spread of electricity in the region and comprises not only the activities of production and distribution of energy but the manufacturing of energy equipment as

¹ López *et al.* (2008) and (2012); Valdaliso *et al.* (2008) and (2010); and ongoing research on the energy and machine tool clusters. Preliminary results of this meta-study can be found in Elola et al. (2012) and Valdaliso et al. (2013).

well. The clusters of electronics and ICT and aeronautics correspond to younger industries that appeared in the 1940s-1950s and in the 1980s-1990s, respectively, and are still in a development phase.

As some other meta-studies have emphasized (Van der Linde, 2003; Brenner and Mühlig, 2007; Belusi and Sedita, 2009), cluster's origins are explained by a combination of local demand, factor conditions, entrepreneurship and the inflow of external knowledge and technology, along with historical legacy. Once established, path dependent mechanisms linked to both cluster and region evolution (development of cluster specific factors, dynamic external economies) and to the clustered firms (strategic, dynamic and absorptive capacities), alongside demand conditions, accounted for their evolution over time (Elola et al., 2012; Valdaliso et al., 2012).

The current size of the six clusters studied is quite heterogeneous (see Table 1). The clusters of electronics and ICT, maritime industries and energy comprise over 300 firms each, while those of machine tools, aeronautics and papermaking are quite smaller, with 105, 60 and 20 firms, respectively. According to employment and turnover figures, the biggest cluster is that of energy (which includes not only the production and distribution of energy, but manufacturing industries such as the production of equipment goods for the electrical and wind energies), followed by electronics and ICT; and the smallest ones are the aeronautics and papermaking. As to their competitive position, the clusters of maritime industries, aeronautics and machine tool are the most export oriented (more than 70 per cent of their turnover was sold abroad in 2011). R&D data are not available for all clusters, but significant differences among those where comparison is possible are observed: from about 1% of turnover in the case of the energy cluster (but with the highest absolute figure) to close to 20% in the aeronautics cluster, being those of electronics & ICT and machine tools in the middle, with a figure close to 5%.

Table 1. Main figures of the Basque clusters in 2011

	Firms (No.)	Employment (No.)	Turnover (M. €)	Exports (M. €)	R&D expenses (M. €)	Exports/ Turnover (%)	R&D/ Turnover (%)
Aeronautics and aerospace ^(*)	60	3,988	690	484	136	70.1	19.7
Electronics and ICT	301	13,100	3,395	995	153	29.3	4.5
Maritime industries	360	6,992	1,060	901	n.a.	85.0	n.a.
Papermaking ^(**)	20	1,650	614	302	n.a.	49.2	n.a.
Energy ^(†)	349	20,864	15,371	n.a.	237	33.2	1.5
Machine tools	105	5,627	925	723	46	78.2	5.0

Source: SPRI, *Observatorio de Coyuntura Industrial* 2012-II.

Notes: ^(*) Estimates; ^(**) Figures are for 2010 and refer only to the firms belonging to the cluster association. ^(†) Original figures have been corrected, including only the ones referred to the Basque country. The ratio of exports over turnover is an estimate.

Along with the detailed information of the in-depth case studies, we have employed for the analysis of the period from the 1970s to the eve of the current economic crisis in 2008, the following data:

- Data series of Gross Value Added (GVA), working hours and employment for the industrial sectors most representative of every cluster between 1982 and 2008;²
- Data series of turnover, exports, employment and number of firms for every cluster, whenever it is possible;³
- Data on exports for every cluster and its share over world exports for the period 1995 to 2008.⁴

Even letting aside the problems of measurement (e.g., of matching sectors with clusters) we agree with Bergman in that “at present there is no single best metric of cluster activity”, which means that sometimes the use of those aforementioned variables have produced different outcomes (Bergman 2008: 127). With this caveat in mind, in the next section we attempt to provide a brief but accurate description of the trajectory followed by every cluster in terms of number of firms, employment, turnover and exports between c. 1974 and 2008, combined with the employment of several qualitative sources.

3. Cluster renewal and cluster creation in the Basque Country over the last thirty years: a bit of context

On the eve of the 1970s crisis, five out of the six clusters already had a distinctive presence in the region, accounting for 16 per cent of the industrial plants and 17 per cent of industrial employment of the Basque Country. In terms of employment, the clusters of energy, shipbuilding, machine tools and papermaking were those most important, while the younger one of electronics and ICT was quite smaller, and that of aeronautics did not exist yet. The same went for the relative importance of those clusters in the Spanish industry (see Table 2).

² Data series on GVA, working hours and employment are taken from the Basque Institute of Statistics, EUSTAT, *Industrial Statistics*, and www.eustat.es from 1982 to 2008. In order to build up a homogenous data series for the whole period, we have been forced to follow the sector aggregations made by EUSTAT. The sectors for which information is provided in the Appendix are (in brackets, their codes of the national classification of economic activities A84 and CNAE-93): papermaking (21/21), machine tools (39/29.401), shipbuilding and other transport equipment (such as aircrafts, but not aircrafts engines) (47-48/35.1-35.5), electricity and oil refining (52 and 23/40.1 and 23), and office and computing machines, electric and electronic parts and equipment (42-43-44/30-31-32).

³ Data come from the cluster-associations and refer either to the whole cluster or to the affiliated firms. In the latter case, we know the representativeness of the cluster association over the whole cluster.

⁴ Data series on exports for every cluster between 1995 and 2008 are taken from Orkestra <http://tools.orquestra.deusto.es/klusterbolak/regions/>, who follows the methodology of Porter (2003) for cluster identification.

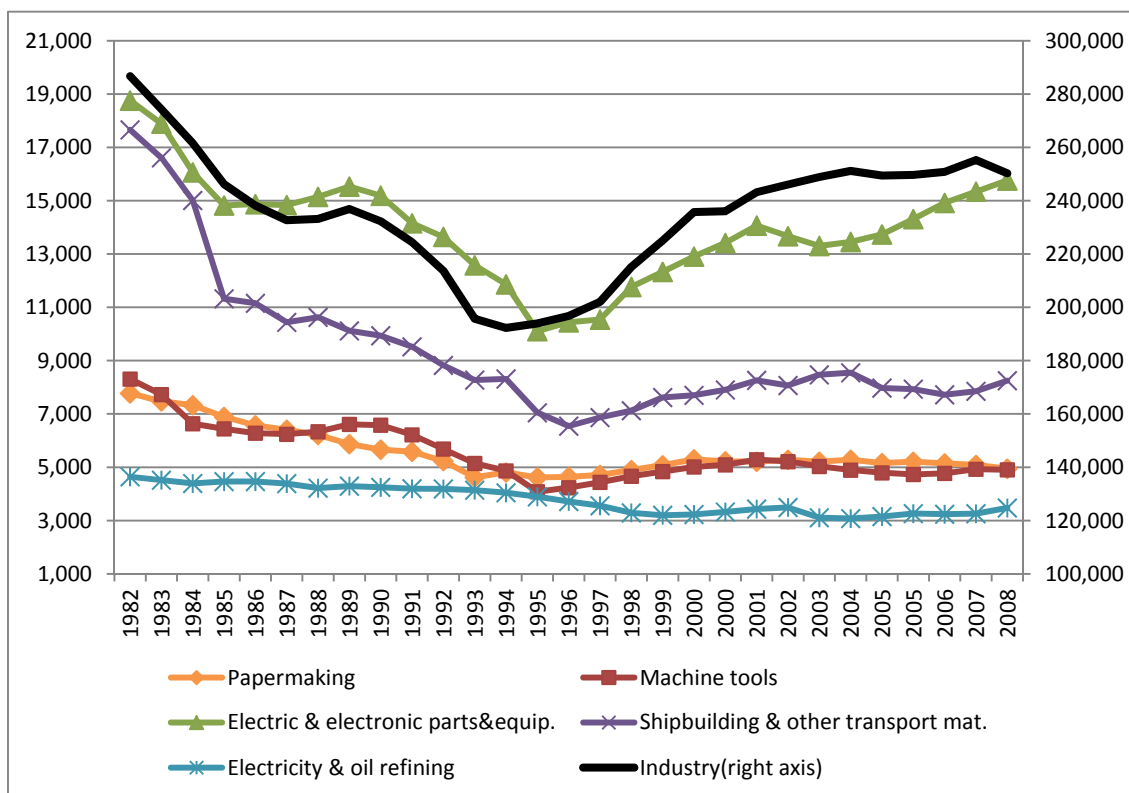
Table 2. Plants and employment of some industrial sectors representative of the clusters studied (1978)

	Plants		Employment	
	No.	% Spain	No.	% Spain
Oil refining, gas and electricity (13 and 15)	5	5.10	405	2.81
Manufacturing of machine tools (322)	184	45.66	11,270	57.53
Manufacturing of electrical parts and equipment (34, except home appliances 345)	254	13.49	15,537	16.97
Manufacturing of computers, office equipment and electronic parts and equipment (33 and 35)	21	6.19	2,035	3.68
Shipbuilding (37)	76	19.44	12,634	21.60
Papermaking (471, 472 and 473)	85	9.76	7,594	13.59
Industry (total)	4,027	7.30	297,381	12.29

Source: Industrial Census of Spain, 1978. Figures refer to plants with 10 or more workers. National Classification of Economic Activities' codes of that Census are between brackets. Sectors 13, 15 and 34 would belong to the energy cluster; sectors 33 and 35 to the electronics and ICT cluster; sector 37 to the maritime industry cluster; and sectors 471 to 473 to the papermaking cluster.

From the late 1970s onwards, the Basque industry faced up a severe economic crisis that went hand in hand with an intense process of globalization and technological change. Mature industries in which the region had long specialised, such as iron and steel, metal products, shipbuilding, machinery and electrical equipment were hit hardest by the combination of a falling demand and a fiercer competition from emerging countries. To make matters worse, Basque firms had lived for decades serving a domestic market highly protected from foreign competition and were scarcely used to compete abroad. After Spain's integration into the EEC in 1986 this scenario changed radically. In spite of this adverse situation and the negative impact of terrorism, the Basque industry managed to survive, change and grow (Porter et al., 2013). Although the share of industry over the GDP of the country had diminished with respect to that of the early 1980s (from 43% in 1980 to 28% in 2008), the Basque country still ranked among the most industrialised regions of EU in 2008 by these ratios (Eurostat, 2010; Aranguren et al., 2012). Industrial employment fell until 1994, then recovered and grew, although the levels of the early 1980s were not reached again (see chart 1).

Chart 1. Employment figures of several industrial sectors of the Basque Country, 1982-2008



Source: EUSTAT. Figures from the building sector are not considered.

In the late 1970s, the Basque papermaking cluster was comprised of about 30 manufacturing firms of paper and pulp (with an average size smaller than their foreign competitors), plus circa 50 firms of paper products, and a small number of manufacturers of machines and equipment for this industry. With half of the papermaking firms created in the 19th century, and the rest before 1940, the cluster went through a maturity phase since the 1950s. As a result of the domestic and international crisis of the late 1970s, demand and prices collapsed (while labour, energy and capital costs increased), and competition became fiercer. The papermaking sector had been strongly oriented to a domestic market highly protected from abroad, but it was no longer the case after 1986: between this year and 1995 the ratio of imports over domestic consumption in Spain went from 22.5 to 42.4 per cent; the ratio of exports over production increased from 18.7 to 30.1 per cent. Besides, the internationalization process in this industry since the 1980s made paper and pulp global commodities, increased cost competition worldwide and resulted in the creation of larger multinational groups to benefit from economies of scale (Valdaliso et al., 2008).

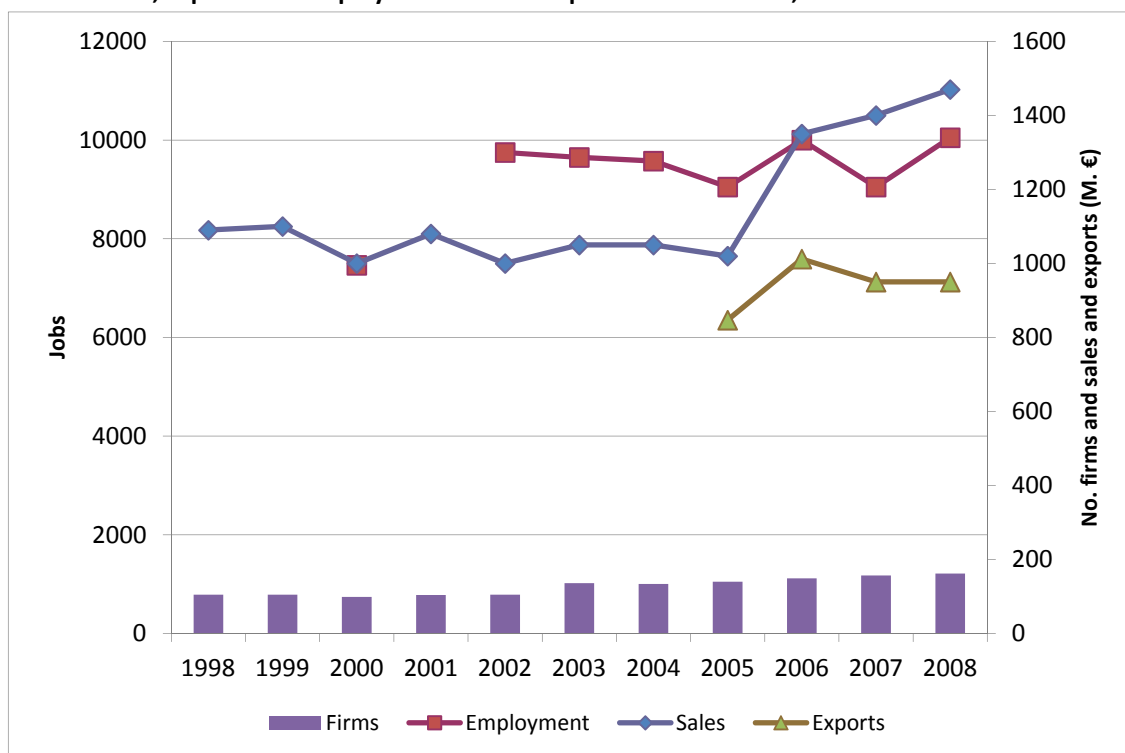
Some of the pulp and papermaking firms of the Basque cluster broke down and exited from the sector. The survivors specialized in a smaller product range, invested in new machinery and equipment and became more international. Some of them were merged into big multinational groups. Employment figures fell between 1982 and 1993, then slightly grew in the second half of the 1990s and later stabilized until 2008 (see chart 1 and Appendix). In 2007 the number of paper and pulp manufacturers had

diminished to 17, and that of manufacturers of papermaking machines and equipment remained stable. Between 1995 and 2008 both sectors have managed to maintain their competitive position in terms of exports, while that of the Basque manufacturers of pulp and paper products has not changed noticeably –in the former case- or even diminished –in the latter one (see chart 6). Some of the firms established a cluster association in 1998, which represents about half of the clustered firms (Valdaliso et al., 2008)

On the eve of the international maritime crisis of the 1970s the Basque cluster of maritime industries was comprised of two big shipyards, highly specialised in the manufacturing of big standardized merchant vessels (tankers and bulk carriers) for the world market, along with about ten medium shipyards, more flexible and with a larger product range, and a bigger number of small shipyards and firms in auxiliary and related industries and services. Since its origins, this cluster's growth had been closely linked to the shipping and fishing sectors of the region, the most important of Spain. Since the 1960s, the cluster passed through a maturity phase, in which the big shipyards increased their export orientation. The collapse of the international shipping market after 1974 hit hardest the largest Basque shipyards specialised in the type of ships most affected by the crisis and by the increasing competition of East Asian nations. They disappeared or, after a substantial reconversion, specialised in other type of vessels (Valdaliso, 2003).

The small and medium shipyards, on the contrary, due to their wider product range and their higher flexibility, specialised in differentiated market niches, where Asian shipbuilders could not compete. This strategy of product differentiation, together with a strong commitment to innovation, helped those shipyards to survive and even grow, although with heavy cuts in employment. The employment figures of the Basque shipbuilding industry declined from 11,740 to less than 4,000 between 1982 and 1995 (see chart 1). During the 1980s and 1990s the auxiliary and related industries (marine engines, parts and equipment) underwent a period of creative destruction: many companies disappeared, while others, either incumbent ones or start-ups, promoted by former technicians from the closed shipyards and/or companies, introduced innovative products and solutions, broadened their product range and went international. Most of the survivors created in 1993 an industry association, ADIMDE, which later on, in 1997, promoted the creation of FMV, the cluster association, which represents about 80% of the firms and 90% of the cluster's sales (Valdaliso et al., 2010). Between 1998 and 2008 sales, exports, number of firms and employment grew, particularly from 2005 to 2008 (see chart 2). However, the competitive position of the two most important sub-clusters, those of shipbuilding and of manufacturing of marine engines, seems to differ in this period (see chart 6).

Chart 2. Sales, exports and employment of the Basque maritime cluster, 1998-2008



Source: FMV. Number of firms associated to ADIMDE, an industry association that belongs to FMV (the rest of the FMV's associates are PROs, banks, port authorities, and government organizations).

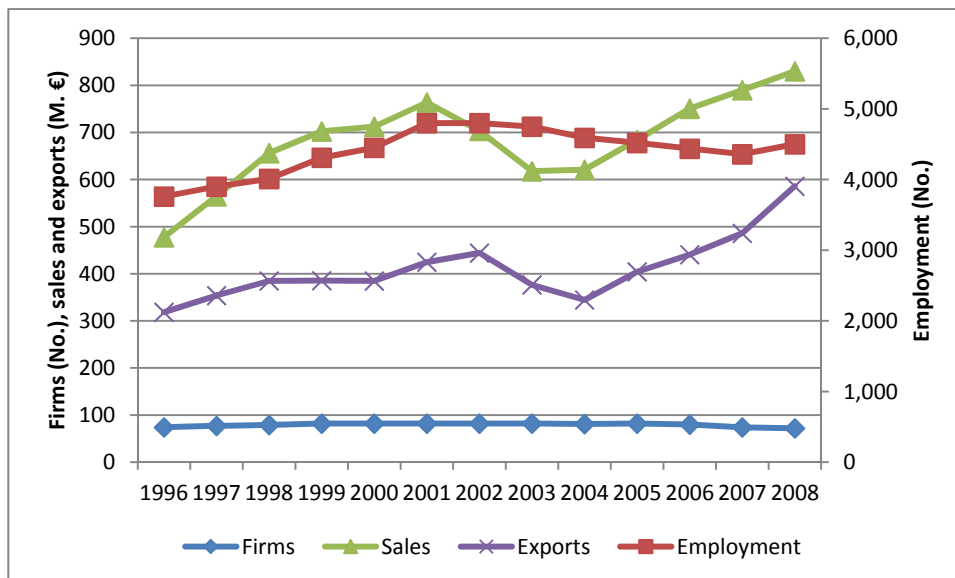
The origins of the machine tool cluster in the Basque country go back to the beginning of the 20th century, due to the existence of good factor conditions (qualified labour and entrepreneurship) and a very important local demand. In the 1970s, after a phase of expansion in the 1950s and 1960s, the Basque machine tool cluster had reached a phase of maturity. It concentrated more than 50 per cent of the firms and a figure of around 60 per cent of sales and employment of the whole sector in Spain. The industry faced up a severe crisis between 1976 and 1985 due to the sharp reduction of the Spanish market, significant cost increases and the appearance of new lower cost competitors –such as South Korea and Taiwan- in the segment of conventional machine tools (with low technological content). On top of that, Basque manufacturers had to cope with the introduction of numerically controlled machine tools and, more generally, microelectronics in this industry. In 1978 only 1 per cent of the machine tools produced in Spain were numerically controlled, far from the figures achieved in Germany and the United Kingdom (around 12 per cent), and even further from those of USA, France and Japan (more than 20 per cent) (Mazzoleni, 1999). As the industry association (AFM) said in 1983: “too many problems at the same time and when the firms had a narrower scope for action” (AFM, 1983). The collapse of the Spanish market forced Basque manufacturers, with a productivity 30 per cent higher than the national average, to go abroad: between 1970 and 1980 the ratio of exports over production grew from 25 to more than 60 per cent.

In the 1980s, the Basque firms had a low scale of production, a narrow product range, and a competitive strategy that was halfway between cost and product differentiation. Unable to compete with lower cost/high scale manufacturers such as Taiwan and

South Korea they decide to upgrade their products making higher quality goods, as manufacturers with a similar plant size were doing in Germany and Italy (Monitor Company, 1993). In order to obtain the increasing resources and capabilities needed to cope with technological change and internationalization, Basque firms, with the help of the regional government and the encouragement of its industry association, merged into larger groups and invested heavily in R&D resources and facilities.

In terms of firms and employment, the sector experienced a steady decline between 1982 and 1995. Then, the number of firms remained stable, while that of employees tended to increase until 2002 and to slightly diminish henceforth (see charts 1 and 3). Sales and exports show an upward trend between 1996 and 2008 (see chart 3). During this period, the cluster has gone international either by the increasing share of exports over sales (that reached 70.6% in 2008) or by the establishment of facilities abroad. Its competitive position over those years, in terms of world exports' share, remained fairly stable (see chart 6).

Chart 3. Firms, employment, sales and exports of the Basque machine tool cluster, 1996-2008



Source: AFM. Figures refer to all the firms, either associated to AFM or not. AFM accounts for 86% of the firms and 97% of the employment of the whole cluster.

The origins of the Basque energy cluster can be traced back to the beginning of the 20th century linked to the spread of hydroelectricity and to the creation of Hidroeléctrica Ibérica (today Iberdrola), a tractor firm of this cluster ever since. From the 1950s to the 1970s the cluster went through a phase of development. It remained strongly focused on hydroelectricity, although new power sources appeared such as thermoelectricity made either from coal or from nuclear power stations, and a new big firm was created in the oil refining industry (Petronor). On the eve of the oil crisis of 1974, the Basque energy cluster was comprised of two big firms in electricity and oil refining, and several small and medium firms in the sectors of electrical parts and equipment, power electronics (transmission and distribution of electricity, T&D) and engineering.

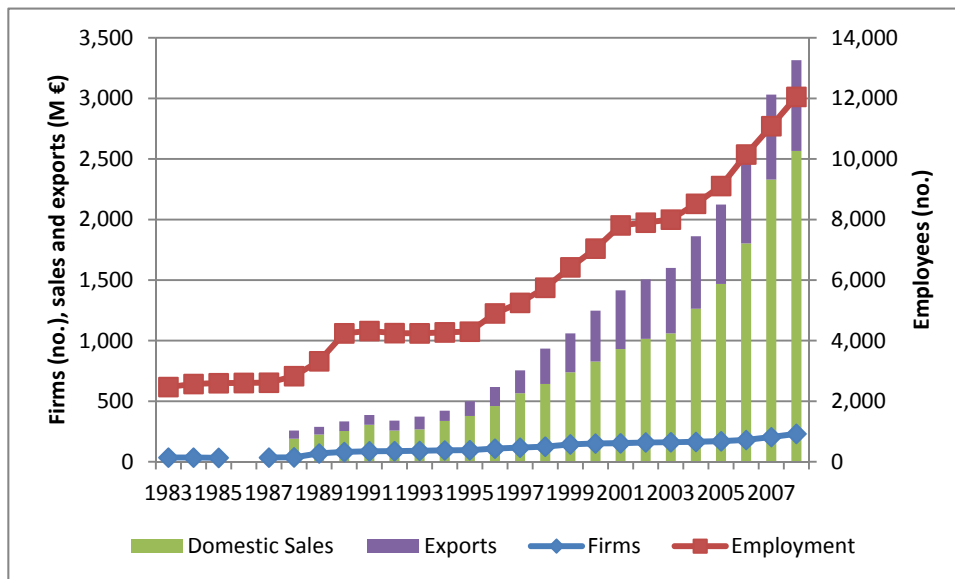
From the 1980s onwards, the Basque energy cluster has experienced a phase of renewal and reorientation, linked to the diversification of traditional energy sources (substitution of gas natural for oil) and the diffusion of renewable energies such as wind, solar and marine energies. The development of these new sectors not only brought about new markets for incumbent firms in this cluster (electric and electronic equipment, engineering) but it has opened up new windows of opportunity for firms in related industries and clusters as well, such as aeronautics, shipyards, and marine equipment manufacturers. Iberdrola entered the wind energy business in 2001 and very soon it became a global leader in terms of wind power capacity. Another younger firm of this cluster, Gamesa (created in 1976), diversified from aeronautics into wind turbines manufacturing in the 1990s, became a key partner of Iberdrola (to which it supplied about 60% of the wind turbines installed in its wind farms) and ranked among the global top 4 turbine manufacturers from 2003 onwards. Both Iberdrola and Gamesa lead global value chains in the wind energy sector into which several firms of the Basque cluster have joined. Many of them have accompanied Iberdrola and Gamesa when they go abroad (Elola, Parrilli et al., 2012; Parrilli coord., 2012).

The expansion of the manufacturing activities of the energy cluster since the mid 1990s helps to explain the growth of employment in the electric and electronic equipment industries (see chart 1). In terms of jobs and turnover, the Basque energy cluster ranks today as the first one among the whole population of clusters in the Basque Country (see table 1). Apart from Iberdrola and Gamesa, it hosts a good number of global leaders and tier 1 suppliers in several niche markets such as transport and distribution of electricity (T&D), engines and equipment, solar energy, and offshore solutions.

The origins of the electronic sector in the Basque country go back to the 1940s and 1950s due to the existence of a growing local demand of power electronics (T&D) and electronic parts and equipment, together with good factor conditions (skilled labour and entrepreneurs from related sectors). The cluster had just entered an expansion phase in the 1970s when it had to cope with the technological divide brought about by the introduction of the microchip and the transition from analogue to digital electronics. The diffusion of technological change in the 1980s opened up a window of opportunity for this sector, as it spread across different sectors from industry to services. The incumbent firms of this cluster completed the transition to digital technologies, reinforced their control over the Spanish market and started or increased their export orientation. Along with these group of founders, many new small firms, either spin-offs of incumbent firms and technological centres or start-ups, were created in the 1980s and the 1990s, not only in electronics but in the expanding sector of information and communication technologies as well (López et al., 2008).

Technological change helps to explain the declining trend of employment in the electric and electronic parts and equipment sectors until 1995, while the ups and downs are explained by economic fluctuations (crisis until 1985 and between 1992 and 1995) (see chart 1). The number of firms affiliated to the industry association, created in 1983, as well as their figures of sales and employment grew until 2008, slightly in the crisis years and more rapidly henceforth (see chart 5). Most of these new firms were born global, and maintained a strong commitment to innovation and internationalization ever since (Valdaliso, 2010; Valdaliso et al., 2011).

Chart 4. Firms, employment, domestic sales and exports of the Basque cluster of electronics and ICTs, 1983-2008

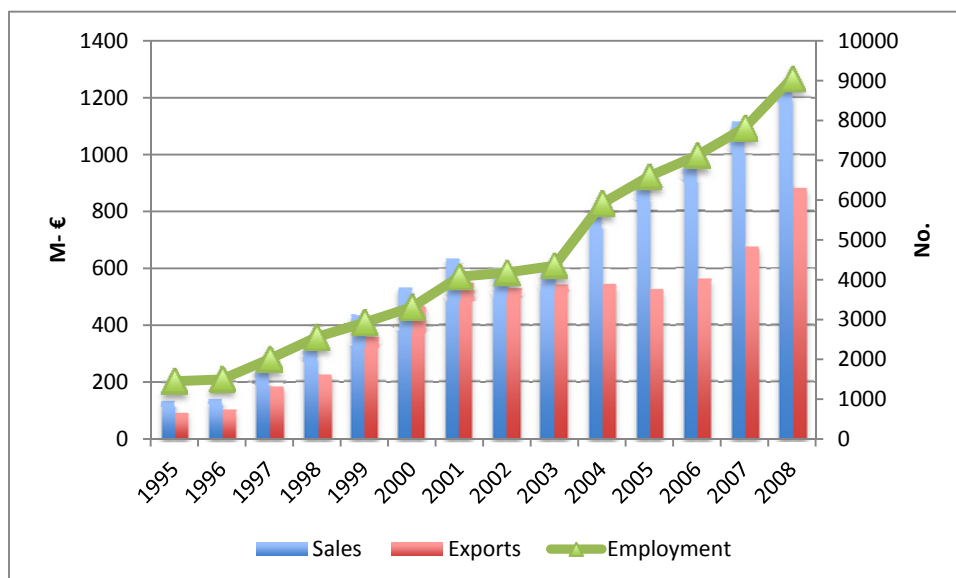


Source: AIEPV and GAIA. Figures refer to firms affiliated to the cluster association, which represents more than 75% of employment of turnover of the whole cluster.

The creation of the Basque aeronautics cluster took place in the 1980s, linked to the initiatives of two big firms from other industries that entered the sectors of aerospace engines (Sener-ITP) and aerospace vehicles (Gamesa, later Aernova) as tier-1 suppliers of global leaders. Since the early 1990s, Sener-ITP and Gamesa received strong financial support from the Basque government, very interested in promoting this cluster in order to offer a new higher value-added market to the special steel manufacturers of the region, which were suffering a severe crisis by that time. A few of those incumbent steel producers and foundries, along with new firms created to manufacture parts in metallic alloys, carbon fibre and composites, joined this cluster in the 1990s, and got inserted in the global value chains of the aeronautics industry, first as suppliers of the Basque anchor firms (ITP and Aernova), later on moving upwards within the GVC and becoming 1st tier suppliers of the global leaders (Elola et al., 2013).

The main figures of the Basque aeronautics cluster (number of firms, employment, turnover) experienced a steady growth between 1995 and 2008, with the exception of the short recession that followed after the terrorist attack of September the 11th (chart 5). Its share over world exports has increased in the same period 1995-2008 (chart 6).

Chart 5. Turnover, exports and employment of the Basque aeronautics cluster, 1995-2008



Source: HEGAN. Figures refer to the firms affiliated to the cluster-association, which represents over 99 per cent of the total turnover.

Another approach to the competitive trajectory of the Basque clusters in this period can be made through the analysis of their exports, a key indicator of regional competitiveness. Based on the database constructed by Orkestra - Basque Institute of Competitiveness, we offer in chart 6 the share of world exports of every cluster between 1995, the first year for which we have export data, and 2008, the eve of the current crisis. The vertical axis shows the world exports' share of each cluster in 2008, while the horizontal axis displays the absolute variation of world exports' share between 1995 and 2008, in both cases in %. Therefore, the 'competitive area' would be located in the upper right side of the chart, while the 'uncompetitive area' would be situated in the lower left one. Finally, the bubble size represents the absolute export value of each cluster in 2008. Given the quite different range of sectors that integrate every cluster (with the exception of the machine tools' one), with different technological content, average wages and productivity, we have opted for representing data at sub-cluster level.⁵

At first glance, most of the sub-clusters within the six clusters studied are located in the right side of the chart, that is, they have improved their competitive position measured by its share over world exports, between 1995 and 2008. It is worth noting that in this period, the Basque share over world exports did not change noticeably (-0.01%). Moreover, most of the sub-clusters displayed have a share over world exports in 2008 higher than the average of Basque exports as a whole, which is of 1.20%.

As to the papermaking cluster, the two most competitive subsectors are paper manufacturing and the manufacturing of equipment for this industry, while those of pulp and paper products are located very close to zero or in the medium left of the chart. With regard to maritime industries, the competitive position of the firms specialised in marine engines is much better than that of the shipyards. The machine

⁵ "Subclusters are subgroups of industries within the cluster" (Porter, 2003: 563).

tool cluster stands out as one of the most important Basque clusters, both by its share over world and Basque exports. Within the broader energy cluster several sectors have to be distinguished. On the one hand, oil refining and production and distribution of electricity (mid-left and upper right of the chart, respectively); on the other, the manufacturing core of this cluster, integrated by medium and large manufacturers of electric T&D equipment (Arteche, Ormazabal, Ingeteam, ZIV) and wind turbines (Gamesa), all of them global leaders in niche markets. The main sub-cluster within electronics and ICT is that of electric and electronics parts, closely related to the manufacturing sub-cluster of energy. Finally, in the aeronautics cluster, both aeroplane and engine manufacturing, sectors lead by global 1st tier suppliers such as Aernnova and ITP, are in the medium-right side of the chart.

Chart 6. World exports' share of the six Basque clusters, 1995-2008

Source: Orkestra. The bubble' size represents the absolute size of each cluster's exports.

4. Discussion

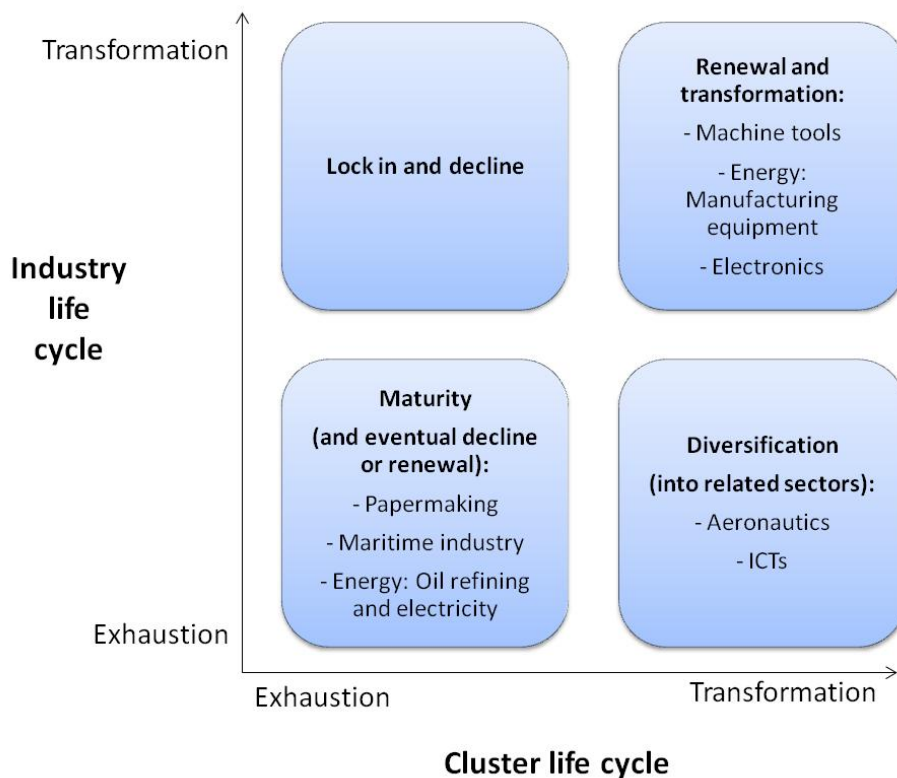
Do Basque clusters follow the life cycle of their respective dominant industries? Based on our theoretical model presented in part 1 and on the empirical evidence shown in part 3, we have placed every cluster in one of the four possible scenarios of industry and cluster life cycles co-evolution. This has not been an easy task because clusters are not internally homogeneous and “do not develop evenly and as a whole” (Martin 2009: 20; Menzel and Fornahl 2010: 224). First, several sub-clusters that correspond to industries with different trajectories may coexist within a given cluster. Due to this reason, we have opted to split the energy cluster into oil refining and electricity, on the one hand, and manufacturing of energy equipment, on the other. And the same goes for the electronics & ICTs cluster, separated into electronics and ICTs.⁶ Secondly, clustered firms may differ in terms of their degree of adjustment to the industry life cycle. We establish the cluster life cycles, and therefore its assignment to one of the four possible scenarios described in Figure 1, based on the development of the cluster’s core of firms and organizations. However, there are some clustered firms that deviate from that cycle and may stay either in an earlier stage (and even, become locked-in and disappear) or partially escape from the industry life cycle by diversifying into new sectors.⁷

At first glance, it seems that four out of the six clusters studied have followed the life cycle of their respective dominant industries (see Figure 2). Over the period analysed in this paper, the Basque papermaking and maritime industries clusters followed the life cycle of their dominant (mature) industries and managed to maintain its competitive position becoming more cost efficient (papermaking), specialising into niche markets (shipbuilding) and innovating and going international (marine equipment). The same goes for the sub-cluster of energy production, where the leading firms (Repsol-Petronor, Iberdrola) have increased their size by a sustained strategy of internationalisation (combined sometimes with other of M&A abroad). The machine tools cluster, and the sub clusters of energy equipment (energy) and electronics (electronics & ICTs) were able to renew and transform themselves thanks to a combined strategy of innovation and internationalization developed by a core group of medium size firms (some of them strongly linked to the large energy producing firms). There are, however, two new clusters that have appeared and developed in the Basque Country in the period under study: those of aeronautics and ICTs. The aeronautics cluster was not created from scratch; its foundations relied on the base of knowledge, resources and capabilities of incumbent firms of other related sectors. With regard to the ICT sub-cluster, it started in the 1980s linked to the diffusion of microelectronics, software and telecommunication technologies.

⁶ Besides, there are other reasons linked to the previous trajectories of the respective sub-clusters, their relative importance and visibility (and hence, political influence), see López et al. (2008) for the electronics and ICT cluster.

⁷ For instance, some firms of the Basque cluster of maritime industries have partially diversified their product and client portfolio by moving into new and more dynamic sectors, such as the renewable energies, as it has also happened in other European regions, see Fornahl et al. (2012).

Figure 2. Co-evolution of industry and cluster life cycles: the Basque country case



Source: authors' elaboration.

Our meta-study fits well with the typology of cluster-based renewal of old industrial regions proposed by Trippel and Tödtling (2008: 207). With different degrees of innovation, the clusters of papermaking, maritime industries, machine tools and energy, would be good examples of 'innovation-based adjustment of mature clusters'; while those of aeronautics and ICT would fit, respectively, into the 'diversification' and 'radical change' types.

Which were the driving local factors behind cluster evolution? Based on previous literature, we briefly discuss the impact of four factors in every cluster: firm structure, base of knowledge and absorptive capacity, social capital and public policies.

Cluster firm structure is strongly related to the business strategies of the clustered firms. The clusters of machine tools, maritime industries and electronics and ICTs are comprised of SMEs that have largely followed a combined strategy of product differentiation, innovation and internationalization; and the same goes for the sub-cluster of manufacturing of papermaking equipment and machinery. The presence of large firms is much more important in the other three clusters, but they have played a very different role. The large papermaking firms, some of them owned by MNEs, follow a strategy of price competition based on scale economies and cost efficiency. In the energy cluster, a few large firms in the oil refining, natural gas and electricity have played a tractor role for the SMEs specialised in energy equipment manufacturing that, in its turn, have followed the same strategy pointed for the SMEs of the machine tools and electronics and ICTs clusters. As to the aeronautics cluster, its origins and

development are strongly linked to the efforts of two large anchor firms well positioned in the GVCs of this industry. In any case, the type of industry does matter as it defines the scope of business strategies available for the clustered firms. For example, the 'commoditization' of paper in the global market forced papermaking firms to follow a cost competition strategy, while in other sectors the strong market segmentation (machine tools) or the fast pace of technological change (energy equipment, electronics and ICTs, aeronautics) broadened the scope of business strategies available (Elola et al., 2013; Valdaliso, 2010; Valdaliso et al., 2011 and 2012).

Some authors have stressed that the dynamic growth of clusters depends on their absorptive capacity, which has two dimensions: the intra-cluster knowledge system (based on the firms' knowledge base, the existence of regional communities of knowledge and technicians, the strength of their universities and technological centres) and the extra-cluster knowledge system (based on the relationship of leading clustered firms with foreign sources of knowledge, cluster insertion in GVCs, foreign direct investment of MNEs) (Giuliani, 2005). So far, we do not have a homogeneous quantitative indicator of the relative strength of the firms' knowledge base in every cluster. However, in depth case studies point to a relatively stronger knowledge base in the machine tools, electronics & ICT, energy and aeronautics clusters (large or medium firms with in house R&D units) than in the papermaking and maritime clusters (except for a few firms, particularly those that diversified into the emerging sector of renewable energies). With the exception of the papermaking cluster, the clusters benefited from a strong research and educational infrastructure (technological centres, training schools and universities) closely related to their needs of qualified workers, researchers and technological solutions (Valdaliso et al., 2011 and 2012). The six clusters appear to be well connected with foreign sources of knowledge, although by means of different channels: MNEs in the papermaking cluster, internationalization processes lead by leading firms (either SMEs, as in the machine tools, maritime industries, electronics and ICT clusters, or large enterprises, as in the energy cluster), and insertion of the large and SMEs of the aeronautics cluster into GVCs (Elola et al., 2013; Valdaliso et al., 2011).

Several studies have pointed out that social capital has enhanced both knowledge creation and absorptive capacity within and between clusters, and have emphasised the key role played by cluster associations in this regard (Valdaliso et al., 2011; Valdaliso et al., 2012; Aragón et al., 2012). However, the level of social capital differs across our sample of clusters studied. It is relatively high in the machine tools, maritime industries, electronics and ICTs, and aeronautics; and relatively low in the papermaking one. As to the energy cluster, the strong business relations that exist between the large energy producing firms and the manufacturing SMEs, act as a substitute for the minor role of the cluster association.⁸ Cluster associations were not only drivers of social capital formation but they promoted inter-firm collaboration in human capital formation, R&D and internationalization as well. Its role was more

⁸ If we take the degree of representativeness of cluster associations (that is, the percentage of clustered firms that are affiliated to the cluster association), it is very high in the aeronautics, machine tools, electronics and ICTs, maritime industries and even energy clusters, but very low (about 50%) in the papermaking one, see data offered in part 3 of this paper.

important in those clusters comprised exclusively of SMEs that were not large enough to face those challenges alone.

Last, but not least, public policies applied in the Basque Country since the 1980s onwards have facilitated cluster-based renewal. The regional government showed a strong commitment in the 1980s to keep and restructure the traditional industries by a retooling strategy based on the creation and development of a technological infrastructure (technology centres and parks), a policy of R&D promotion (in house and external), and a strong emphasis on human capital formation. This policy was maintained in the 1990s, but combined with others: a cluster policy aimed at promoting the creation of several cluster based initiatives in the six (and many other) clusters studied; and the first attempts to promote diversification into other sectors that did not exist in the region, such as aeronautics, telecommunications, and creative industries. This strategy of industrial diversification (a 'de-locking' mechanism according to Martin and Sunley, 2006) continued throughout the 2000s but now with a clear stress on science-based sectors, such as bio-sciences, nano-technologies and advanced manufacturing (Aranguren et al., 2012; Aranguren, Magro et al., 2012).

5. Conclusions

In this paper, based on the evidence of the Basque Country, an old industrialized region that managed to avoid lock-in situations, renewing its industrial base by upgrading some of its mature clusters and by promoting new high technology ones (Aranguren et al., 2012), we contribute to the literature on cluster life cycles. We specifically add new insights to the research on the relationship between clusters life cycles and the trajectory of their corresponding industries, by introducing an analytical framework where we can classify clusters depending on the exhaustion and/or renewal/transformation phases of both clusters and industries. Our work contributes to the existing research in three different ways.

First, we conclude that both clusters and their corresponding industries do not follow a "deterministic" development path. That is, they do not follow a straightforward cycle of emergence, growth, maturity and decline, but both mature industries and clusters can reinvent themselves, renewing or transforming their knowledge base, and getting into a new growth phase.

Second, although clusters tend to co-evolve with industries, we see that clusters are not just a local representation of an industry. That is, clusters do not necessarily follow the life cycle of their dominant industry (Bergman, 2008; Menzel and Fornahl, 2010; Martin and Sunley, 2011). Some clusters are able to escape from the tyranny of the industry life cycle and from lock-in situations, while others cannot. In our specific case, four out of the six clusters studied have followed the life cycle of their respective dominant industries: some followed the life cycle of their dominant (mature) industries and managed to maintain their competitive position, and others were able to renew and transform themselves. There are, however, two new clusters that have appeared and developed in the Basque Country in the period under study. With different degrees of innovation, the clusters of papermaking, maritime industries, machine tools and energy, would be good examples of 'innovation-based adjustment

of mature clusters'; while those of aeronautics and ICT would fit, respectively, into the 'diversification' and 'radical change' types.

Related to the previous issue, and following existing literature, we show that local peculiarities also matter for the evolution of a particular cluster (Menzel and Fornahl, 2010; Martin and Sunley, 2011). In this point, we contribute by deepening our understanding on which are the local factors that mostly influence the trajectory of a cluster in relation to the trajectory of its dominant industry. Our analysis shows that four factor groups affect mostly these dynamics: cluster structure (in terms of type of firms and agents, and their business strategies), knowledge base and absorptive capacity (which is related to the firms' strategic and dynamic capabilities), social capital, and public policies.

Our study has implications for policy makers, as it highlights those elements that policies should focus on in order to promote cluster competitiveness. First, social capital is an element that policies should focus, that is, policies should promote the development of inter-firm networking and collaboration and community building (Enright, 1998; 2003; Porter, 1998). Second, policies should also be oriented to increase the knowledge base and absorptive capacity of clusters, through the promotion of innovation and R&D activities (of firms and other agents of the regional innovation system) and internationalization.

Acknowledgements

Financial support of MINECO (HAR2012-30948) and Basque Government (IT807-13) is acknowledged.

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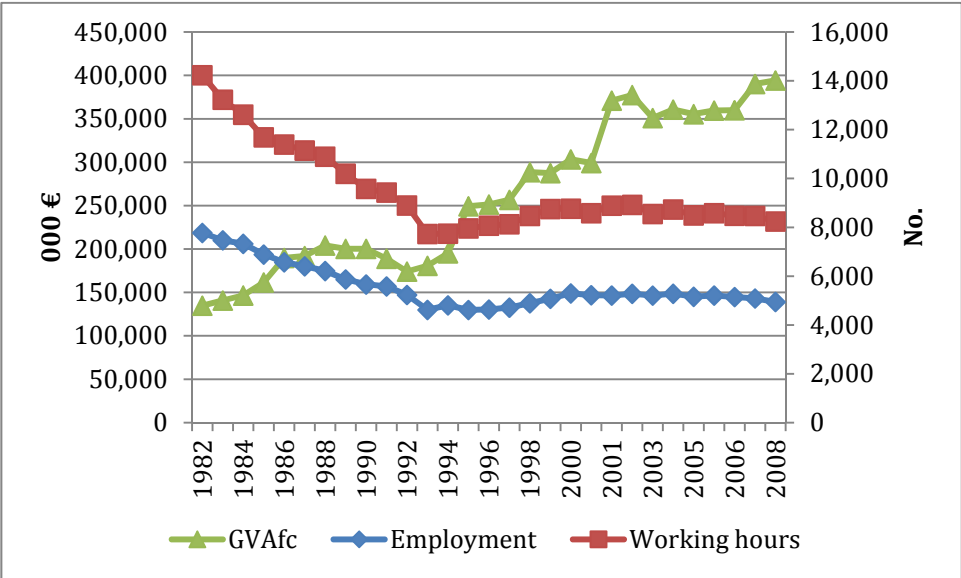
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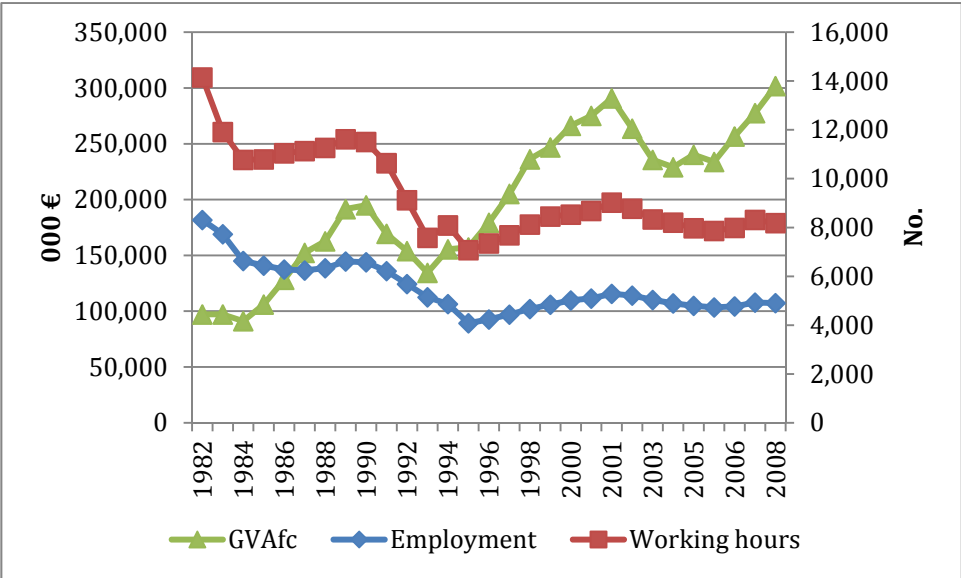
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Appendix. GVA, employment and working hours in some industrial sectors representative of some of the clusters studied, 1982-2008

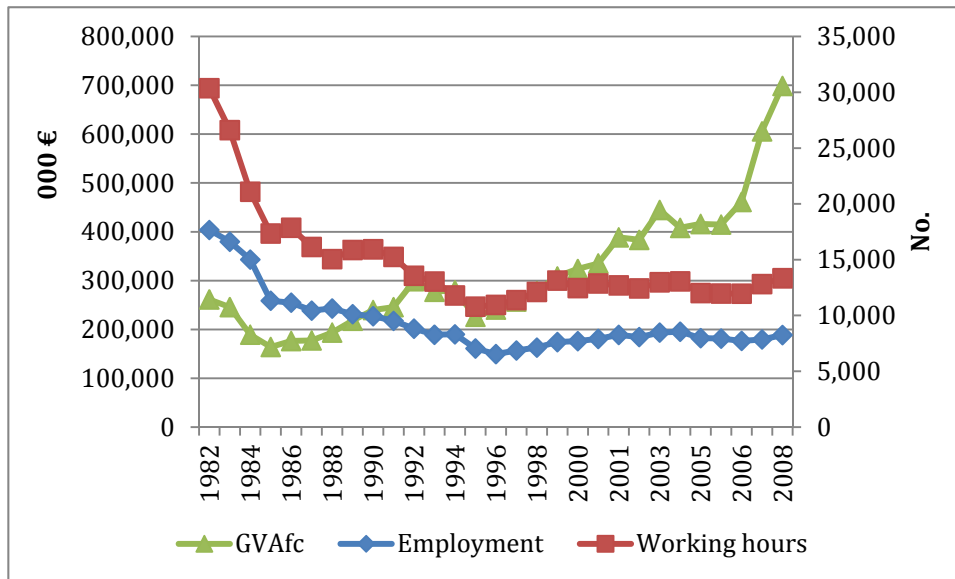
Papermaking



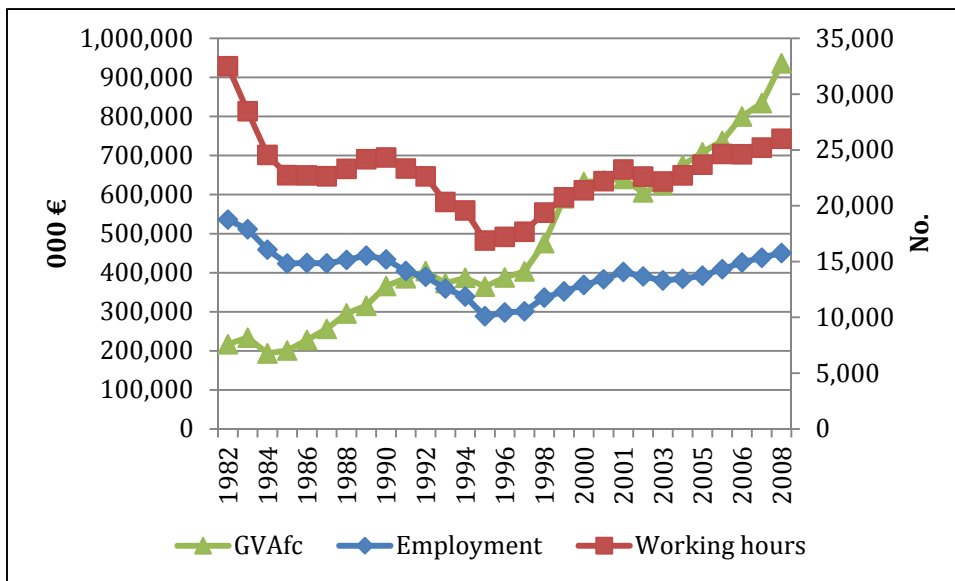
Machine tools



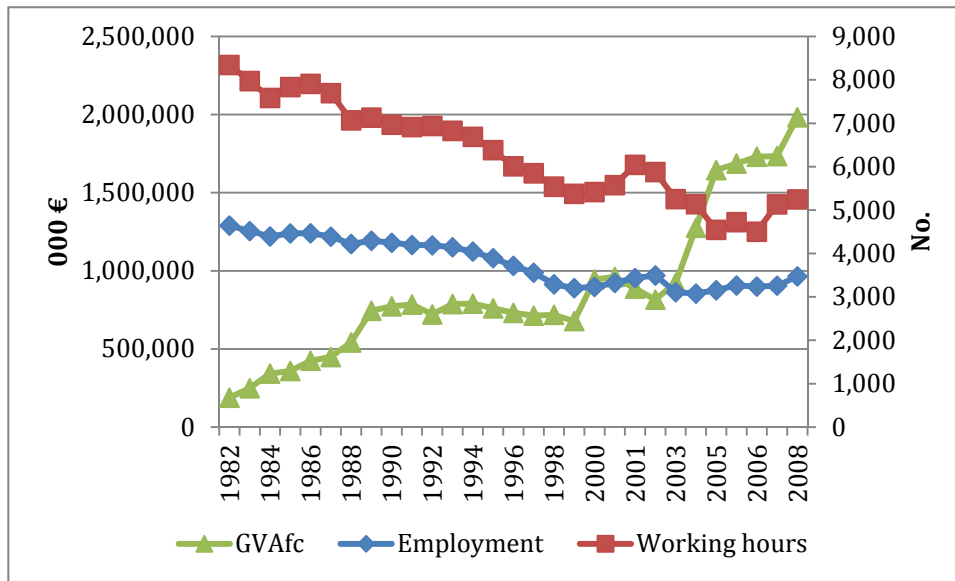
Shipbuilding and other transport material and equipment



Electric and electronics parts and equipment, office equipment and computing



Oil refining, gas and electricity



Source: EUSTAT, *Cuentas Industriales* 1982-1995; and www.eustat.es, 1995-2008. GVA at factor cost, in thousand of current Euros.